M.Tech-1(PECD/C&I)

ADSP

ADVANCED DIGITAL SIGNAL PROCESSING

Answer SIX Questions including Q.No.1 which is compulsory

Symbols used in this question have their usual meaning.

The figures in right-hand margin indicate marks

FM-70

Time:3 Hours

Q.1 (a) Distinguish between the energy signal and the power signal. Give examples. [2X10]

(b) Find the discrete-time signal having the following Fourier transform

$$X(\omega)=\begin{cases}0, & 0\leq|\omega|\leq\omega_0\\ 1, & \omega_0<|\omega|\leq\pi\end{cases}$$

(c) Distinguish DFT from DTFT.

(d) Given the FIR filter y(n)= x(n) + 5 x(n-1). Find its unit sample response.

(e) What is frequency response? What is the physical significance?

(f) What is the limit cycle? How to avoid this?

(g) How many complex multiplications and additions are required to compute 64 point DFT in FFT?

(h) Show the periodicity property of a twiddle factor.

(i) What is the linear phase characteristic of FIR filter? Suggest one application area.

(j) Why parametric methods are better than nonparametric methods used for power spectrum estimation?

Q.2 (a) Test the following discrete systems as per the given direction. [2+2+6]

i) y(n) = a+x(n), Linearity test (ii) y(n)= $4x(-n^2)$, Causality test

(b) Test whether the system y(n)=2-x(-n+1) is shift invariant and stable.

(c) The impulse response of a LTI system is h(n)={1,2,1,3}. Find the response of the system if the input is x (n) = {1, 2, 1, 2}. Use overlap and save method.

Q.3(a) Compute the linearly convolved output using DFT from the following data. [5+5]

N=3, x(n)= -1,2,1 and h(n)=1,2,1

(b) Discuss modulation, time reversal and dilation properties of DFT.

Q.4(a) What is windowing technique ? How it is used for design of digital FIR filters ? [4+6]

(b) Find the system function H(z) of the digital Butterworth filter that meets the following specifications :

(i) 1-dB ripple in the passband $0\leq|\omega|\leq 0.3\pi$

(ii) At least 40 dB attenuation in the stop band $0.3\pi\leq|\omega|\leq\pi$.

Use bilinear transformation method with T=1.

Q.5(a) Draw the flow graph for a 4-point FFT by DFT method. Explain how the same flow graph can be used to compute inverse DFT. [5+5]

(b) Compute the IDFT of the sequence X(k)={3, 2+j, 1, 2-j }.

Q.6(a) Using impulse invariance method obtain the digital transfer function and the Corresponding filter structure [4+4+2]

$H_a(s)=\{1/(s+0.5)(s^2+0.5s+2)\}$. Assume T=1 s.

(b) Draw the corresponding IIR filter structure.

(c) Write two frequency domain properties of IIR filters.

Q.7(a) The input to the system $y(n)=0.95\, y(n-1) + x(n)$ is applied through ADC. Assume that the input is quantized to 8 bits. Compute the power produced by the quantization noise. [6+2+2]

(b) What you mean by dynamic range in DSP?

(c) What is a recursive filter? What is coefficient quantization effect in IIR filter?

Q.8 (a)Consider a signal $x(n)=s(n)+w(n)$, where s(n) is an AR(1) process that satisfies the difference equation $s(n)=0.6\, s(n-1) + v(n)$, where {v(n)} is awhite noise sequence with variance $\sigma_v^2=0.64$ and {w(n)} is a white noise sequence with variance $\sigma_w^2=1$. The processes {v(n)}and {w(n)}are uncorrelated. Designan optimum IIR Wiener filter of length M=2 to estimate {s(n)}. [5+5]

(b) Consider the linear system described by the difference equation

$y(n)=0.8\, y(n-1) + x(n) + x(n-1)$, where x(n) is a wide-sense stationary process with zero mean and autocorrelation $\gamma_{xx}(m)=(1/2)^{|m|}$.

(i) Determine the autocorrelation $\gamma_{yy}(m)$ of the output. .

(ii) Determine the power density spectrum of the output {y(n)}.