INDIAN INSTITUTE OF TECHNOLOGY

Date: April 28, 2010
Spring Semester 2009-2010
2nd Year B.Tech..

Time: 3Hrs. Full Marks: 100
Dept. Electronics & ECE
Sub. Name: Signals and Systems

No. of students: 90
Sub. No. EC21004

⟵ PLS. READ INSTRUCTIONS CAREFULLY ⟶

*Answer all five questions. Answers should be **brief, to the point and legible**. Sketches wherever appear should be **neat and properly labeled**. Justification, steps, assumptions must be **unambiguously** mentioned. All parts of a question must be answered **at one place**.*

Q1. (a) Given, a system represented by unit sample response $h_1(n)$ is a Low Pass Filter. Show if another system with unit sample response $h_2(n) = (-1)^n\, h_1(n)$ represents a Low Pass Filter/ High Pass Filter/Band Pass Filter/Band Stop Filter.

(b) Explain the significance of unit circle in z-plane.

(c) Explain aliasing in time domain.

(d) Explain what makes Weiner-Hopf filter optimal.

(e) Realize $y[n] + 0.8\, y[n-1] - 0.2\, y[n-2] = x[n] - 0.6\, x[n-1] + 0.5\, x[n-2]$ in hardware using only two delay elements.

5x4

Q2. (a) Compare Continuous Time Fourier Transform and Discrete Time Fourier Transform.

(b) State and prove the time scaling property of Discrete Time Fourier Transform.

(c) A 90 degree phase shifter is a system with frequency response

$$H(e^{j\omega}) = -j \text{ for } 0<\omega<\pi \quad \text{and} \quad H(e^{j\omega}) = j \text{ for } -\pi<\omega<0$$

Find unit sample response of the system.

(d) Consider a three point moving average filter $y[n] = \{x[n] + x[n-1] + x[n-2]\}/3$
Find (i) its Discrete Time Fourier Transform (ii) plot its magnitude and phase response and (iii) calculate its 3-dB cut-off frequency.

4+3+5+(2+4+2)

Q3. (a) Compare z-transform and Discrete Time Fourier Transform.

(b) State and prove the final-value theorem in z-Transform.

(c) Find the inverse z-transform of $X(z) = (1-az^{-1})^{-2}$, $|z| > |a|$

(d) The output $y[n]$ of a discrete-time LSI system is found to be $2(1/3)^n u[n]$ when the input $x[n] = u[n]$.
Find (i) the impulse response $h[n]$ of the system and
(ii) the output $y[n]$ when input $x[n]$ is $(1/2)^n u[n]$.

3+4+6+(4+3)

Q4. (a) Compare Discrete Fourier Transform (DFT) and Discrete Time Fourier Transform.

(b) How circular convolution is related to DFT? How linear convolution can be obtained from circular convolution?

(c) Compute DFT coefficients $X[k]$ for $x[n] = [1, 0, -2, 1]$. Hence, compute inverse DFT of $X[k]$.

(d) Find N-point DFT of the sequence $x[n] = \cos(n\omega_0)$ where $0 \leq n \leq N\text{-}1$.
Compare DFT coefficients $X[k]$ when $\omega_0 = 2\pi m/N$ where m integer and when $\omega_0 \neq 2\pi m/N$. Explain the difference.

2+(2+2)+(3+3)+(3+3+2)

Q5. (a) Compare strict sense stationary process and wide sense stationary process.

(b) For a linear system with impulse response $h(t)$, consider the input $x(t)$ as wide sense stationary process with mean μ_X and autocorrelation $R_X(\tau)$. Find mean and autocorrelation of the output $y(t)$.

(c) The probability of error in transmission of digital data through a noisy channel is 0.0001. If each transmission is an independent event, what is the probability that more than two data are erroneous out of 1000 transmissions?

(d) Digital audio tape drives have sampling frequency of 48 kHz while a compact disk player operates at a rate 44.1 kHz. Show using block diagram how you can design a sampling rate converter that can send disk output directly to tape driver for playing audio. Find parameter for each block. Considering band limited audio signal draw frequency description at input-output of each block.

3+(2+3)+5+(2+3+2)

⟶ END OF Q. PAPER ⟵