Signal and Systems

EEL 205 N **MAJOR EXAMINATION** **Time 2 Hrs**

Total Marks: 40

Note: a) All questions are compulsory.
b) Only 10% Marks are allocated towards the correctness of the process and technique used to solve the problem

1 $x[n]$ is a real valued causal sequence with discrete time Fourier Transform $X(e^{j\omega})$. Determine $x[n]$ if the imaginary part of $X(e^{j\omega})$ is given by : $\mathrm{Im}\{X(e^{j\omega})\} = 3\sin(2\omega) - 2\sin(3\omega)$.

6 Marks

2 $y_r[n]$ is a real-valued sequence with discrete time Fourier transform $Y_r(e^{j\omega})$. The sequences $y_r[n]$ and $y_i[n]$ as shown in Fig1. are interpreted as real and imaginary part of a complex sequence $y[n] = y_r[n] + j\,y_i[n]$. Determine the choice of $H(e^{j\omega})$ in Fig. 1 so that $Y(e^{j\omega})$ is $Y_r(e^{j\omega})$ for negative frequencies ($-\pi < \omega < 0$) and zero for positive frequencies ($0 < \omega < \pi$) between $-\pi$ and π.

6 Marks

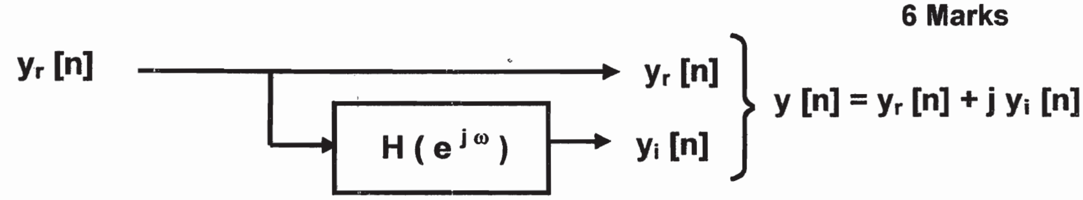


Fig. 1

3 A system for examining the spectral content of a signal $x[n]$ is shown in fig. 2 (a). The filters $h[n]$ in each channel are identical three-point non-causal FIR filters with an impulse response $h[n] = h_0\,\delta[n] + h_1\,\delta[n+1] + h_2\,\delta[n+2]$. The filter output is sampled at $n = 0$ to obtain the sequence $y_k[n]$, $k = 0,1,2,3$.

8 Marks

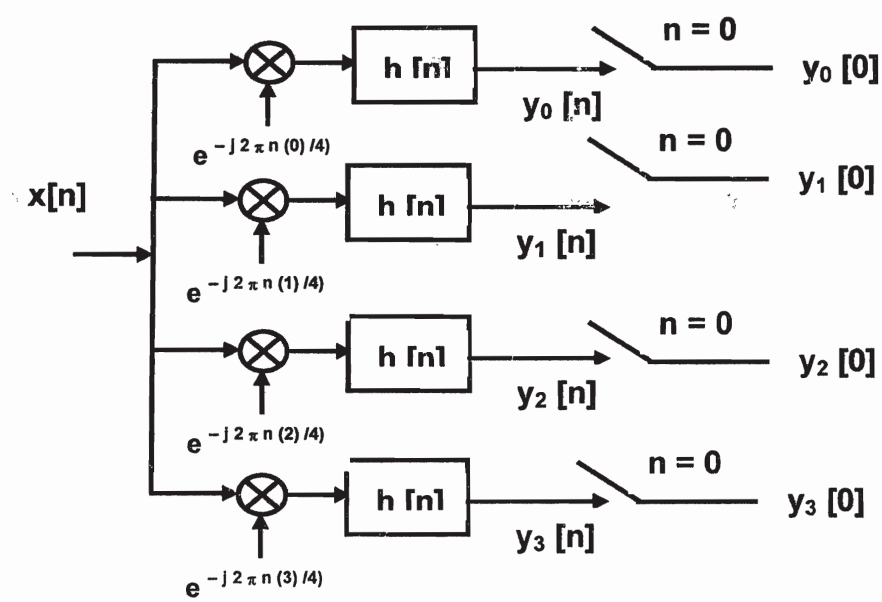
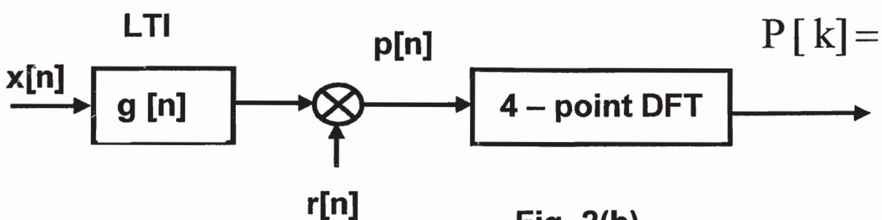


Fig. 2(a)

An alternative to the system in Fig 2 (a) has been proposed using a 4-point discrete Fourier transform as shown in Fig 2(b).



$$P[k]=\sum_{n=o}^{3} p[n]e^{-j2\pi kn/4}$$

Fig. 2(b)

Determine g [n] and r [n] so that P [k] = y_k [0]

4 The following information is known about a discrete time LTI system with input x[n] and output y[n].

6 Marks

a. If x[n] = $(-2)^n$ for all n, then y [n] = 0 for all n
b. If x[n] = $(1/2)^n$ u [n] for all n, then y[n] for all n is of the form $y[n] = \delta[n] + a(1/4)^n u[n]$, where "a" is a constant
c. Determine the value of the constant "a"
d. Determine the response y[n] if the input x[n] = 1 for all n.

5 For an LTI system the input x [n] and output y[n] are related by the difference equation: y [n-1] – (5 / 2) y [n] + y [n +1] = x[n]. This system may or may not be stable or causal.
Considering the pole-zero pattern associated with this difference equation, determine three possible choices of the unit impulse response of the system.

6 Marks

6 Find whether the impulses responses listed below corresponds to a stable system.

a. $h_1[n] = n\cos((\pi/4)n)u[n]$

b. $h_2[n] = 3^n u[-n + 10]$

2 Marks

7 Solve the Initial value problem given below:

$$\frac{d^2 y(t)}{dt^2} + 4\frac{dy(t)}{dt} = \cos(t-3) + 4t \qquad y(3)=0 \quad y'(3)=7$$

6 Marks