discussion week 3

EE 3015
Signals and Systems

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University of Minnesota, Twin Cities

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Contents

1 Questions **2**

2 Problem 1 **3**

3 Key solution **5**

1 Questions

Discussion 4 - practice problems For MidExam1. wed oct 10

problem1. Consider The convolution $y(t) = x(t) * h(t)$ with

$$x(t) = \cos(\pi t) \cdot [u(t+1) - u(t-1)]$$

$$h(t) = u(t+1) - u(t-1)$$

Compute $y(t)$ For $t < 0$

problem2. Calculate all Fourier Series Coeff. of Signal $x(t)$

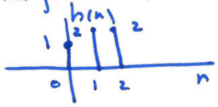
$$x(t) = \sin\left(\frac{3\pi t}{2}\right) + \cos(7\pi t)$$

identify all frequencies? - what is The fundamental frequency ω_0 ?

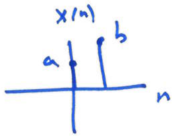
problem3. obtain Discrete Convolution of $y(n) = x(n) * h(n)$ where $x(n) = a^n u[n-5]$, $h(n) = u(-n)$

Assuming $|a| < 1$

problem4. The impulse response of a discrete LTI system is

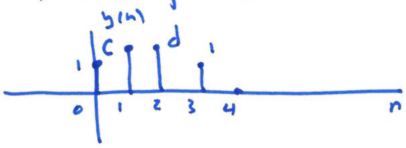


$h(n) = [\underset{\substack{\uparrow \\ n=0}}{1} \; 2 \; 2]$



when input $x(n)$ is $x(n) = [\underset{\substack{\uparrow \\ n=0}}{a} \; b]$

if The output $y(n)$ is



Find $\left[\begin{array}{l} a \overset{?}{=} \;\&\; b = ? \\ \underset{=?}{c} \;\&\; d = ? \end{array}\right]$

2 Problem 1

Solution

Folding $h(\tau)$ to becomes $h(-\tau)$. Therefore, when $1+t<-1$ or $t<-2$, then $y(t)=0$ since there is no overlap.

When $-1<1+t<1$, or $-2<t<0$, then there is partial overlap. In this case

$$\begin{aligned} y(t) &= \int_{-1}^{1+t} \cos(\pi\tau)\,d\tau \qquad -2<t<0 \\ &= \frac{1}{\pi}\left[\sin(\pi\tau)\right]_{-1}^{1+t} \\ &= \frac{1}{\pi}\left[\sin(\pi(1+t)) - \sin(-\pi)\right] \\ &= \frac{1}{\pi}\sin(\pi(1+t)) \end{aligned}$$

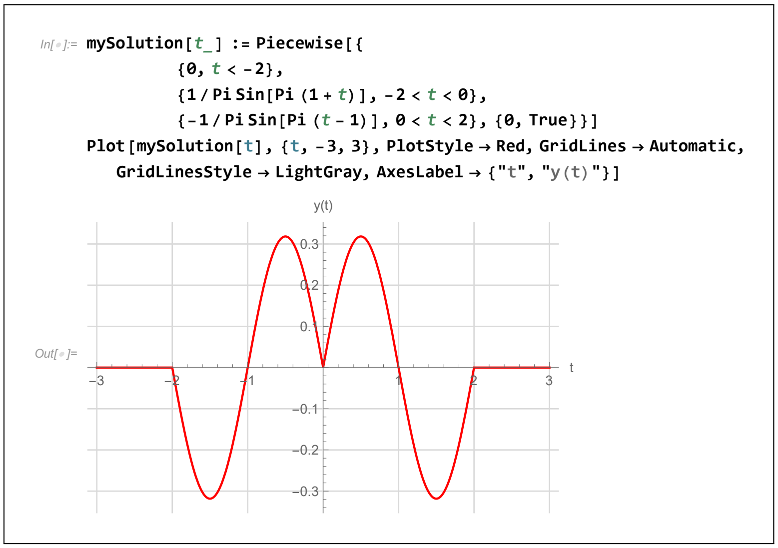
When $1<1+t<3$, or $0<t<2$, then there is partial overlap. In this case

$$\begin{aligned} y(t) &= \int_{t-1}^{1} \cos(\pi\tau)\,d\tau \qquad 0<t<2 \\ &= \frac{1}{\pi}\left[\sin(\pi\tau)\right]_{t-1}^{1} \\ &= \frac{1}{\pi}\left[\sin(\pi) - \sin(\pi(t-1))\right] \\ &= \frac{-1}{\pi}\sin(\pi(t-1)) \end{aligned}$$

When $3<1+t$ or $t>2$ then $y(t)=0$ since there is no overlap any more. Hence solution is

$$y(t) = \begin{cases} 0 & t\leq -2 \\ \frac{1}{\pi}\sin(\pi(1+t)) & -2<t\leq 0 \\ \frac{-1}{\pi}\sin(\pi(t-1)) & 0<t\leq 2 \\ 0 & t>2 \end{cases}$$

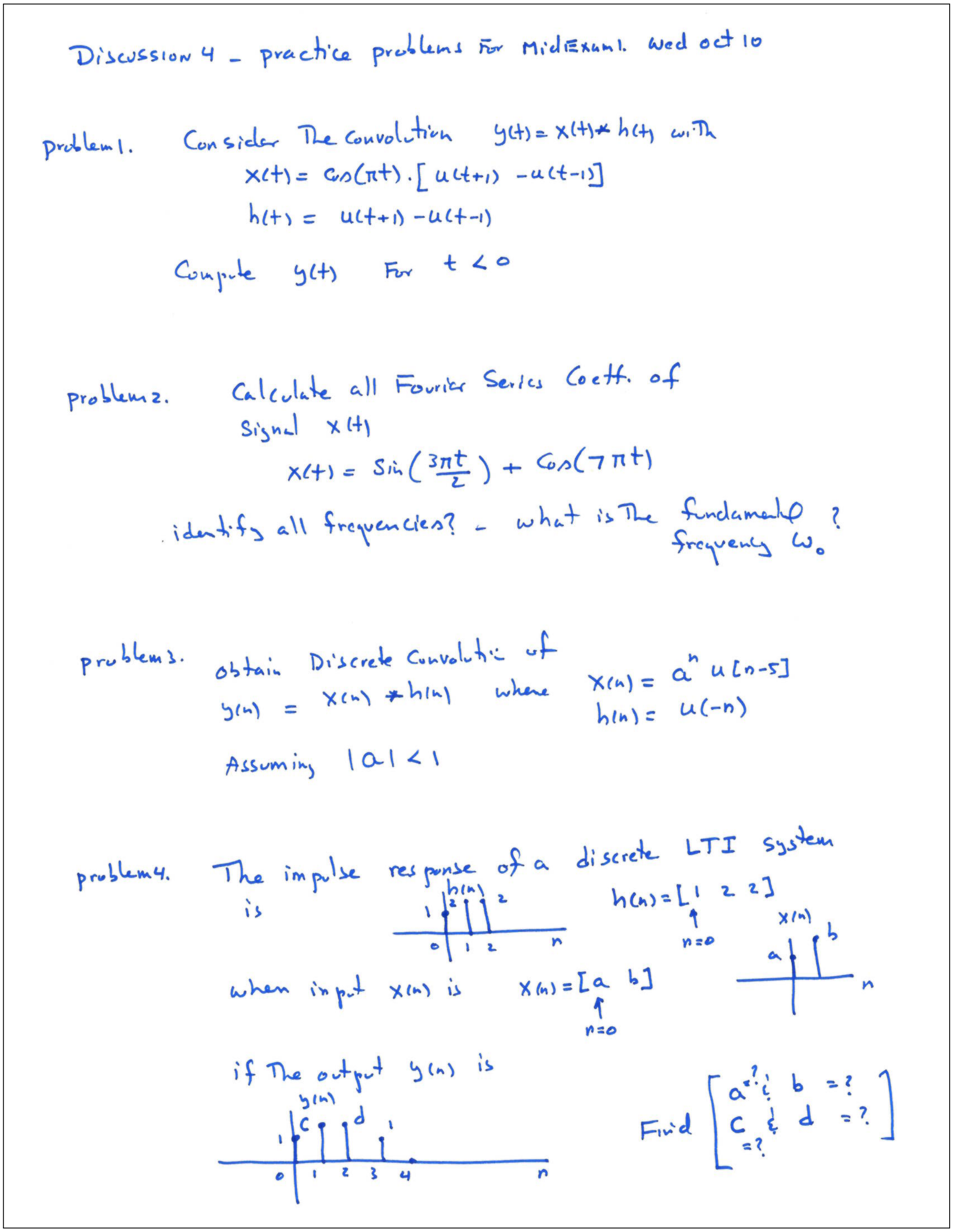
The following is a plot of $y(t)$



```
mySolution[t_] := Piecewise[{
            {0, t < -2},
            {1 / Pi Sin[Pi (1 + t)], -2 < t < 0},
            {-1 / Pi Sin[Pi (t - 1)], 0 < t < 2}, {0, True}}]
Plot[mySolution[t], {t, -3, 3}, PlotStyle → Red, GridLines → Automatic,
   GridLinesStyle → LightGray, AxesLabel → {"t", "y(t)"}]
```

Figure 1: Plot of $y(t)$

3 Key solution



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$h(n) = [\underset{\overset{\uparrow}{n=0}}{1} \ 2 \ 2]$

when input $x(n)$ is $x(n) = [\underset{\overset{\uparrow}{n=0}}{a} \ b]$

if The output $y(n)$ is

Find $\left[\begin{matrix} a \overset{?}{=} \ \& \ b = ? \\ \underset{=?}{c} \ \& \ d = ? \end{matrix}\right]$