EE1330: Digital Signal Processing, Spring 2017

Indian Institute of Technology Bhilai <u>Assignment Solutions</u>

NAME-----Pintu Kumar **ROLL No.**—EE16B1020

1. Solution

(a) and (b)

(1) (a)
$$2(n) = e^{j\pi n/6}$$
 $w = \pi = 2\pi f$
 $f = 1$

(for a discrete signal to be periodic, f must be stadional humber.

 $\Rightarrow f = \text{orational no.}$
 $\therefore 2(n)$ is periodic

 $T = \frac{1}{f} = 12$ sec

(b) $2(n) = e^{j(3\pi n/4)}$
 $w = 3\pi = 2\pi f$
 $\Rightarrow f = \frac{3}{8} = \text{Rational no.}$
 $\therefore 2(n)$ is periodic signal.

 $T = \frac{1}{f} = \frac{3}{8} \times 3ec = 8$
 $\Rightarrow f = \frac{3}{8} \times 3ec = 8$

1. (c)

1(c)
$$x(n) = (\lim_{n \to \infty} (x_n))/(x_n)$$

Let N be the pivid of $x(n)$
 $\frac{1}{n} \leq \frac{g_{in}(x_n)}{x_n} \leq \frac{1}{x_n}$

Let this interval be

 $I_1 = [\frac{1}{n}n \mid \frac{1}{x_n}]$

Since, $x(n)$ is posidic with policid N
 $\frac{g_{in}(x_n)}{x(n+N)} = \frac{g_{in}(x_n)}{x_n}$
 $\frac{1}{x(n+N)} = \frac{g_{in}(x_n)}{x(n+N)} \leq \frac{1}{x(n+N)}$
 $I_2 = [\frac{1}{x(n+N)} \mid \frac{1}{x(n+N)}]$

Case I: If n is positive integer then $I_2 \subset I_1$
 $\frac{1}{x(n+N)} = \frac{1}{x(n+N)} = \frac{1}{x(n+N)}$

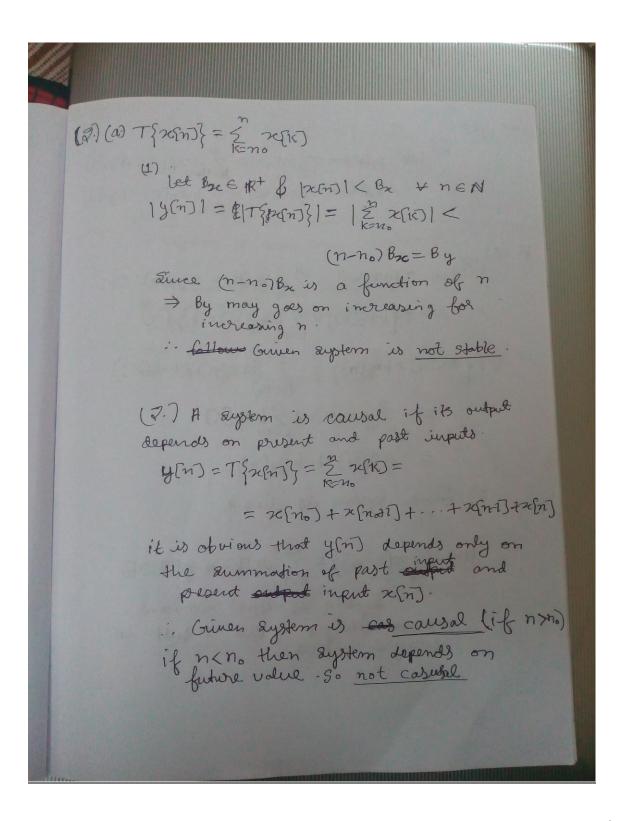
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 $\frac{1}{x(n+N)} =$

(2.) Solution

(a.)



F. (a) (3) Let
$$T\{ax(n)\} = \frac{2}{k\pi n}a^{2}(n) = ay(n)$$

$$T\{bx_{2}(n)\} = \frac{2}{k\pi n}b^{2}x_{2}(n) = by(n)$$

$$T\{ax(n) + bx_{2}(n)\} = \frac{2}{k\pi n}(ax(n) + bx_{2}(n))$$

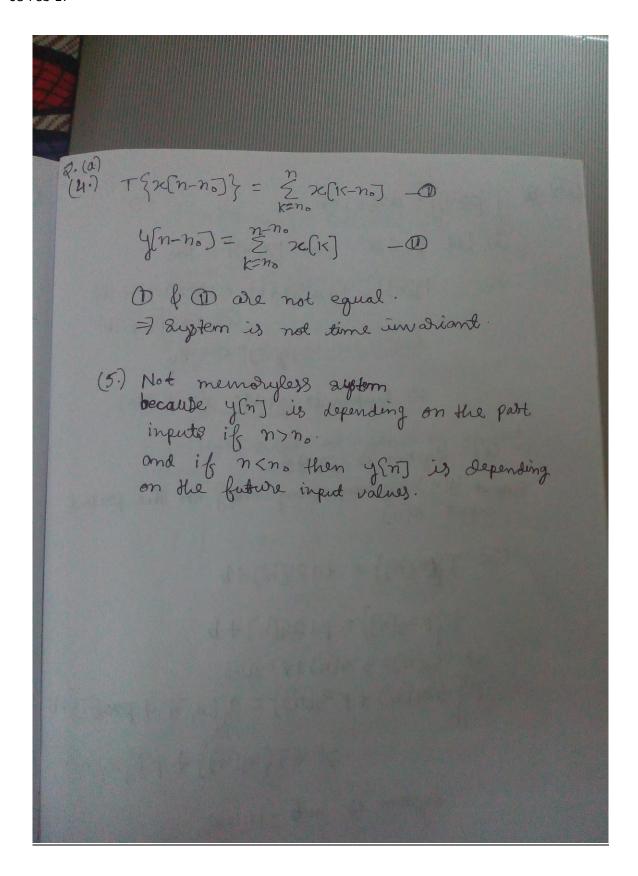
$$= \frac{2}{k\pi n}ax(n) + \frac{2}{k\pi n}b^{2}x_{2}(n)$$

$$= ay(n) + by(n)$$

$$= ay(n) + by(n)$$

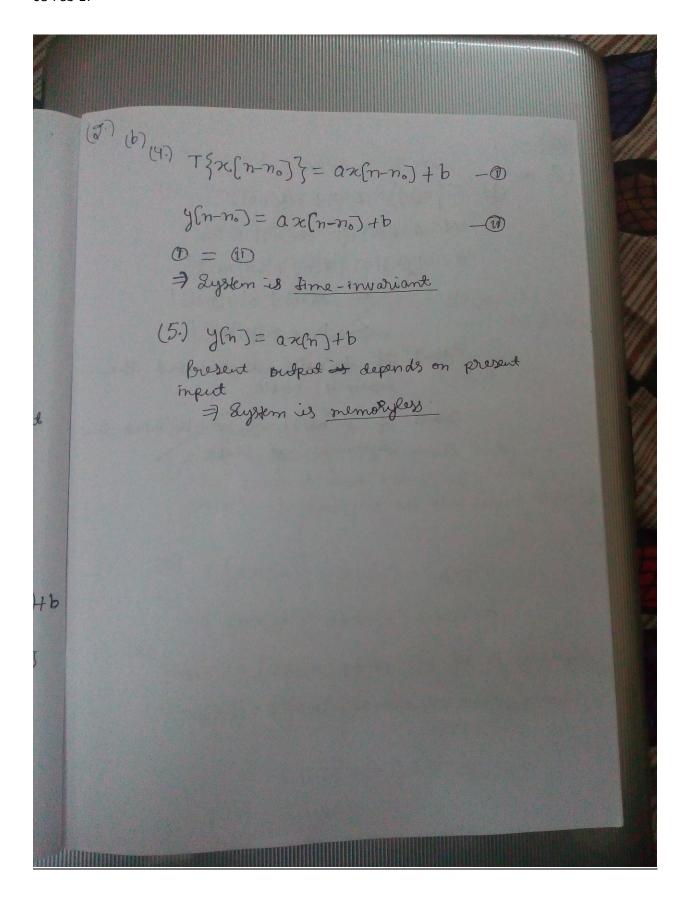
$$= ay(n) + by(n)$$

$$= builen system is linear.$$



(2) (b)

```
(2) (b) T {oc[n]} = ax(n) +b
                                                     (2.)
       (1) Let BrETR+ and 12cm] < Bre
               14(m) = 1 arc(m) +b1 < 10(12(m) 1+1b)
                                < 101 Bze. + 161
                            14[m] 1 < By
                =) System is stable (: B1B0)
        (2) Lyskin is callal
      Output 4[n] is depending only on the present
       (3) Taci[n] = tazi[n] +b
            T{px2[n]} = pax[n]+b
          let 2(3(n) = t 24(n) + p22(n)
          T { t x ( [n ] + pres(n) } = a(t x ( n ) + pres(n) ) + b
                         # もてをなられるトアでれるとかろう
            : . System is note - linear
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(2) (c)

```
(9) (c) (1.) + 32(n) = 2(n) + 32(n+1)
               Let BRERT & 126m] < Bx
                    => 14[n] = |2(n] + 3 u[n+i]
                               < 1x(n) 1 + 3 14(n+1)
                                < Bx +3 (-3/4[n+1] (3)
                                                     unit 3tep franction
                     => 1y(n) is kounded.
                 : . System is stable.
              2002 Lugtern es causal.

Lince output y(n) depends only on
the present and values of input
then
                    re[n]. (u[nti) is not the input signal)
               (3) + {axi[n]} = axi[n] + 3u[n+i)
            T\{b\kappa_2[n]\}=b\kappa_2[n]+3u(n+i) let \kappa_3[n]=(\alpha\kappa_i[n]+b\kappa_2[n]) ke third input
              T{225(n)} = T{ans(n) + b25(n)} = ans(n) + b25(n) + 3us(n+1)
                              # aT{n(n)}+ bT{n(n)}
                .. Not linear
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(2) (C) Jelouging input;

(4) TS 2(n-no) = 2(n-no) + 3u(n+1) -0 y[n] = x(n) + 3u(n+1)Delaying ondrud; y[n-n] = x(n-n) + 3u(n-n+1) - 0田丰间 = aysten is not time invariant (5.) Memoryless system
ousput just depends on current
input value of 20(17)

(3.) Solution

```
solin) is the input sequence to
  LTI system then the output soquence is given by convolution sum as,
   yln)= { (h(k). 2(mx))
   where h[k] is the unit impulse response
   Of the system.
  y(n)= $ (h(k) 2(nk))+ $ (h(i) - 2(nk))
 Now the first summation represents a
 uneighted sum of future values of
 input, which must be zero for this system to be causal.
     ie. 2 (h(k) x(nx))=0
which can be guaranted only if
       :. h[n]=0 + n<0
    Hence Browned.
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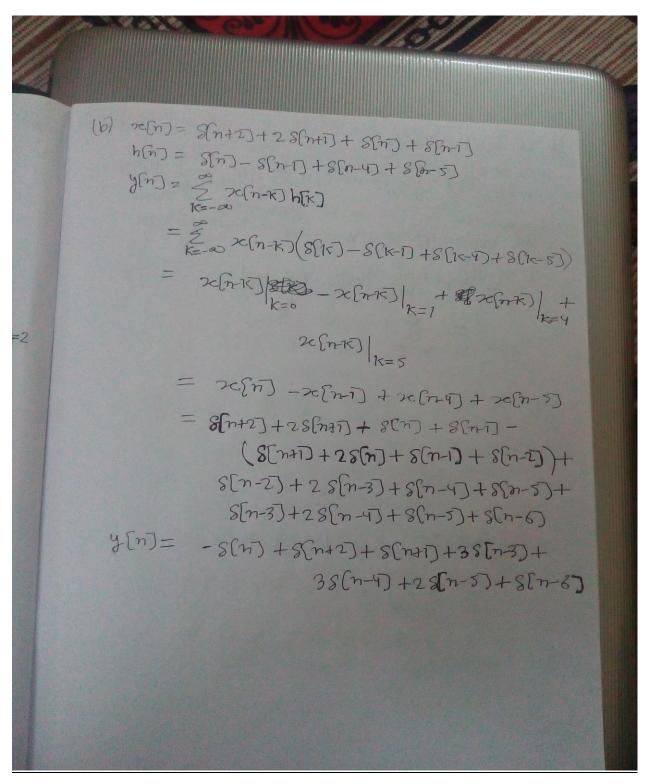
(4.) Solution

(a)

(4) Reporte Consolution Sum:

(a)
$$2(n) = 23(n) - 13(n-1)$$
 $h(n) = -3(n) + 23(n-1) + 3(n-2)$
 $J(n) = \sum_{k=0}^{\infty} 2c(n-k) h(k)$
 $= \sum_{k=0}^{\infty} 2c(n-k) \left(-3(k) + 23(k-1) + 3(k-2)\right)$
 $= -2c(n-k) \Big|_{k=0} + 22c(n-k) \Big|_{k=1} + 2c(n-k) \Big|_{k=2}$
 $= -2c(n) + 22c(n-1) + 2c(n-2)$
 $= -2c(n) + 3(n-1) + 4c(n-2) + 2c(n-2) + 2$

(4,) (b)



(5.) Solution

(b) h[n] =
$$\frac{1}{2}$$
 | $\frac{1}{2}$ | $\frac{1}{$

(6.) Solution

(a)

```
(6) (gimen; 25(n) + 25(n) + 5(n))
     40[m] = -S[n+2]-25[n+1)+25[m]+8[n-2]
 @ 20(m)= 8(n-1)+28(m-2)+38(m-3)+48(m-4)+
             38[n-5]+28[m6]+8[n-7]
   => 24[n] = 26[n-2)+226[n-1]+26[n-6]
   T {26にかり= youn= T {26にかえ) +2次。いかみんからう
        = yoln-2) +240(n-9) + yoln 6)
                       (Since, 20 is input of
LTI System)
       = -8[n] - 28[n-1] - 28[n-2] - 28[n-3] + 28[n-5]
           +28[n-6]+28[n-7]+8[n-8]
> T{2,[n]}=y[n]=-s[n]+2(-s[n]-s[n])-
                    S[n-3] + S[n-5] + S[n-6] +
S[n-7]) + S[n-8]
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(b)

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6(b) y(n) = 2c(n) * h(n)

Toking fourier Tomorrofoum

F{y(n)} = F{x(n)} + {h(n)}
              Fining = Fryeng
            h[n] = f^{-1} \{f\{y[n]\}\}
f[n] = -s[n+2] - 2s[n+1] + 2s[n-1] + s[n-2]
Since f\{s[n-n,j]\} = e^{-j\omega n}.
              7 \{y_0[n]\} = -e^{2j\omega} - 2e^{j\omega} + 2e^{-j\omega} + e^{-2j\omega}
              {200[n]} = S(n+1) +2S[n] +S[n-1]

\begin{aligned}
& + \{76(n)\} = e^{j\omega} + 24e^{j\omega} \\
& + \{n\} = y^{-1}\} = 2(e^{j\omega} + 2i\omega) + e^{j\omega} + e^{j\omega} \cdot (e^{j\omega} + e^{j\omega}) \\
& + 24e^{j\omega} + 24e^{j\omega}
\end{aligned}

             h(n) = f^{-1} \left\{ \frac{(e^{-j\omega} - e^{j\omega})(e^{-j\omega} + e^{j\omega} + 2)}{(e^{-j\omega} + e^{j\omega} + 2)} \right\}
h(n) = f^{-1} \left(e^{-j\omega} - e^{j\omega}\right)
             h(n) = S(n-1) - S(n+1)
```