



2

12 Pages

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List the numbers of the questions you have attempted	Office Use
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Q2	02
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Total	37/100

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Q 1)

a)

Answer = C.

$$f(t) = \begin{cases} 2, & \text{for } -1 < t < 1 \\ 1, & \text{for } -2 < t < -1 \\ 1, & \text{for } 1 < t < 2 \end{cases}$$

$$e^{j\omega t} \cdot F(f(t)) = f(j\omega) = \int_{-\infty}^{\infty} f(t) e^{-j\omega t} dt$$

$$F(j\omega) = \int_{-\infty}^{\infty} f(t) e^{-j\omega t} dt$$

$$x(1) = 2(-1) + 2(0) + 2(1)$$

Answer = C.

b) $f(t)$, $F(j\omega) = \frac{1}{\omega^2 + 1} e^{-\frac{2\omega^2}{(\omega^2 + 1)}}$, $f(t-2)e^{jt}$.

formula: $f(t-t_0) \xrightarrow{FT} F(j\omega) e^{-j\omega t_0}$

$= f(t-2)e^{jt} \xrightarrow{FT} \frac{1}{\omega^2 + 1} e^{-\frac{2\omega^2}{(\omega^2 + 1)}}$

~~$f(t-2)e^{jt} \xrightarrow{FT} \frac{1}{\omega^2 + 1}$~~

$\omega = \omega - \omega_0$

$\omega_0 = 1$ for $f(t)$

$\omega = \omega - 1$

$\therefore f(t-2)e^{jt} \xrightarrow{FT} \frac{1}{(\omega-1)^2 + 1} e^{-\frac{2(\omega-1)^2}{(\omega-1)^2 + 1}} e^{j\omega t_0}$

$= f(t-2)e^{jt} \xrightarrow{FT} \frac{1}{(\omega-1)^2 + 1} e^{-\frac{2(\omega-1)^2}{(\omega-1)^2 + 1}} e^{j\omega t_0}$

$= f(t-2)e^{jt} \xrightarrow{FT} \frac{1}{(\omega-1)^2 + 1} e^{-\frac{2(\omega-1)^2}{(\omega-1)^2 + 1}} e^{j(\omega-1)2}$

$= f(t-2)e^{jt} \xrightarrow{FT} \frac{1}{(\omega-1)^2 + 1} e^{-\frac{2(\omega-1)^2}{(\omega-1)^2 + 1}} e^{-j2(\omega-1)}$

$\therefore$ answer = b.

$Q_1 = 2+1+2+1+1+2+2+2 = 13$

12/11
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Q2.

a)

$$x(n) = \begin{cases} \frac{1}{3}, & \text{for } -1 \leq n \leq 1 \\ 0, & \text{otherwise.} \end{cases}$$

$$\phi = -1$$

$$2 = 0$$

$$3 = 1$$

$$N=3 \therefore N-1=2$$

$$x(n)$$

$$X(k) = \sum_{n=-\infty}^{\infty} x(n) e^{-j2\pi kn} \quad \text{at } \omega = \frac{2\pi k}{N}, \quad k=0, 1, \dots, N-1$$

$$X(0) = \frac{1}{3} \left(-1 \left(e^{-j2\pi \frac{0}{3}} \right) + 0 \left(e^{-j2\pi \frac{0}{3}} \right) + 1 \left(e^{-j2\pi \frac{0}{3}} \right) \right)$$

$$X(0) = (-1) (1) + 0 + 1$$

$$X(0) = (-1) (1) + 0 + 1$$

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Q2

4(i) FIR filters are used in DSP applications to remove interference. ?

FIR filters have orders, a order of $N > 4$ would be more effective.

0

0

Hamming window

$$y(n) = w(n) \times x(n)$$

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b) ii)

$$x(n) = \{12.5, 8, 8, 12.5\}$$

$$N = 4$$

$$\therefore N-1 = 3$$

$$w(n) = 0.54 - 0.46 \cos\left(\frac{2\pi n}{N-1}\right)$$

$$x(1) = 0.54 - 0.46 \cos\left(\frac{2\pi \cdot 12.5}{3}\right)$$

$$= 0.127$$

$$x(2) = 0.54 - 0.46 \cos\left(\frac{2\pi \cdot 8}{3}\right)$$

$$= 0.099$$

$$x(3) = 0.54 - 0.46 \cos\left(\frac{2\pi \cdot 8}{3}\right)$$

$$= 0.099$$

$$x(4) = 0.54 - 0.46 \cos\left(\frac{2\pi \cdot 12.5}{3}\right)$$

$$= 0.127$$

$$y(n) = \{0.127, 0.099, 0.099, 0.127\}$$

$$p_2 = 1+1 = 2$$

SAR:

Q3 a) i) $S(t) = A \cos(2\pi f_m t + \phi)$ $I(t) = S(t) \times L_{\text{in phase}}$

$$L_{\text{in phase}} = \cos(2\pi f_0 t)$$

$$L_{\text{out phase}} = -\sin(2\pi f_0 t)$$

$$S(t) = 3 \cos\left(2\pi \times (1200) + \frac{\pi}{6}\right)$$

$$L_{\text{in phase}} = \cos(2\pi (1150))$$

$$L_{\text{out phase}} = -\sin(2\pi (1150))$$

$$I(t) = S(t) \times L_{\text{in phase}}$$

$$I(t) = \left[3 \cos\left(2\pi (1200) + \frac{\pi}{6}\right) \times \cos(2\pi (1150)) \right]$$

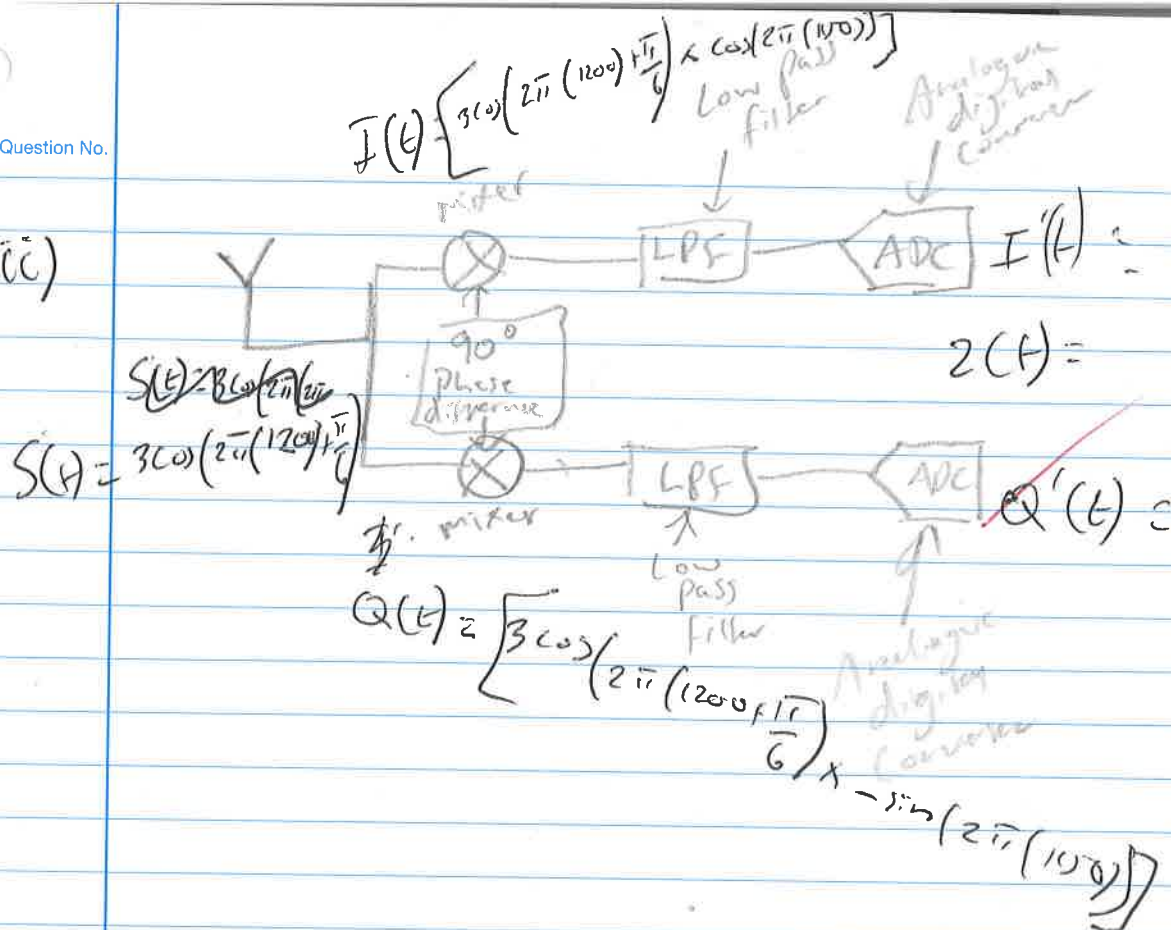
$$Q(t) = \int S(t) \times L_{\text{out phase}}$$

$$Q(t) = \left[3 \cos\left(2\pi (1200) + \frac{\pi}{6}\right) \times (-\sin(2\pi (1150))) \right]$$

$$Z(t) = ?$$

$$\cos A \cdot \sin B = \frac{1}{2} (\sin(A+B) - \sin(A-B))$$

(c)



4

④

(ii)

The local oscillator (LO) is used to down convert the RF signal into baseband components. The LO signal combines/mixes with the RF signal.

Sum of frequencies: $f_{RF} + f_{LO}$

difference of frequencies = $f_{RF} - f_{LO}$

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b)

$$f_{\text{interference}} = 1230 \text{ MHz}$$

$$f_{LO} = 1150 \text{ MHz}$$

$$\text{Sum, } 1230 + 1150 = 2380 \text{ MHz} = \text{Sum}$$

$$\text{difference, } 1230 - 1150 = 80 \text{ MHz} = \text{difference}$$

②

The above mixing process shifts the interference signal to the sum and difference frequencies.

Therefore, a frequency of 50-60 MHz should be retained in the signal.

ii) The output frequency with interference will ~~off~~ become distorted.

The output frequency ~~will~~ without interference will be clear and easy to recover.

iii) ~~add~~ Add filtering, such as Butterworth, FIR filters, which will filter out the undesired frequencies ~~e.g. interference~~ ~~interference~~.

Ensure the ~~desired~~ interference signal has been shifted far enough away from RF signal.

$$Q_3 = 3 \times 2 + 4 + 2 + 2 + 2 = 17$$

Q1a) $y(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$

i)
$$\begin{array}{cccc} & 0 & 1 & 2 & 3 \\ \text{Even} & 2 & 4 & 4 & 2 \\ \text{odd} & 1 & 3 & 3 & 1 \end{array}$$

Even Even 2 4
Even odd 4 2
odd odd 3 1
odd even 1 3

$y(A) = \{2, 4, 4, 2, 3, 1, 1, 3\}$

ii)
$$W_N^k = e^{-j \frac{2\pi}{N} k}$$

$W_8^0 = 1$

$W_8^1 = 0.707 - j0.707$

$W_8^2 = -0.707 - j0.707$

$W_8^3 = -0.707 + j0.707$

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$W_4 = 2 + j3$

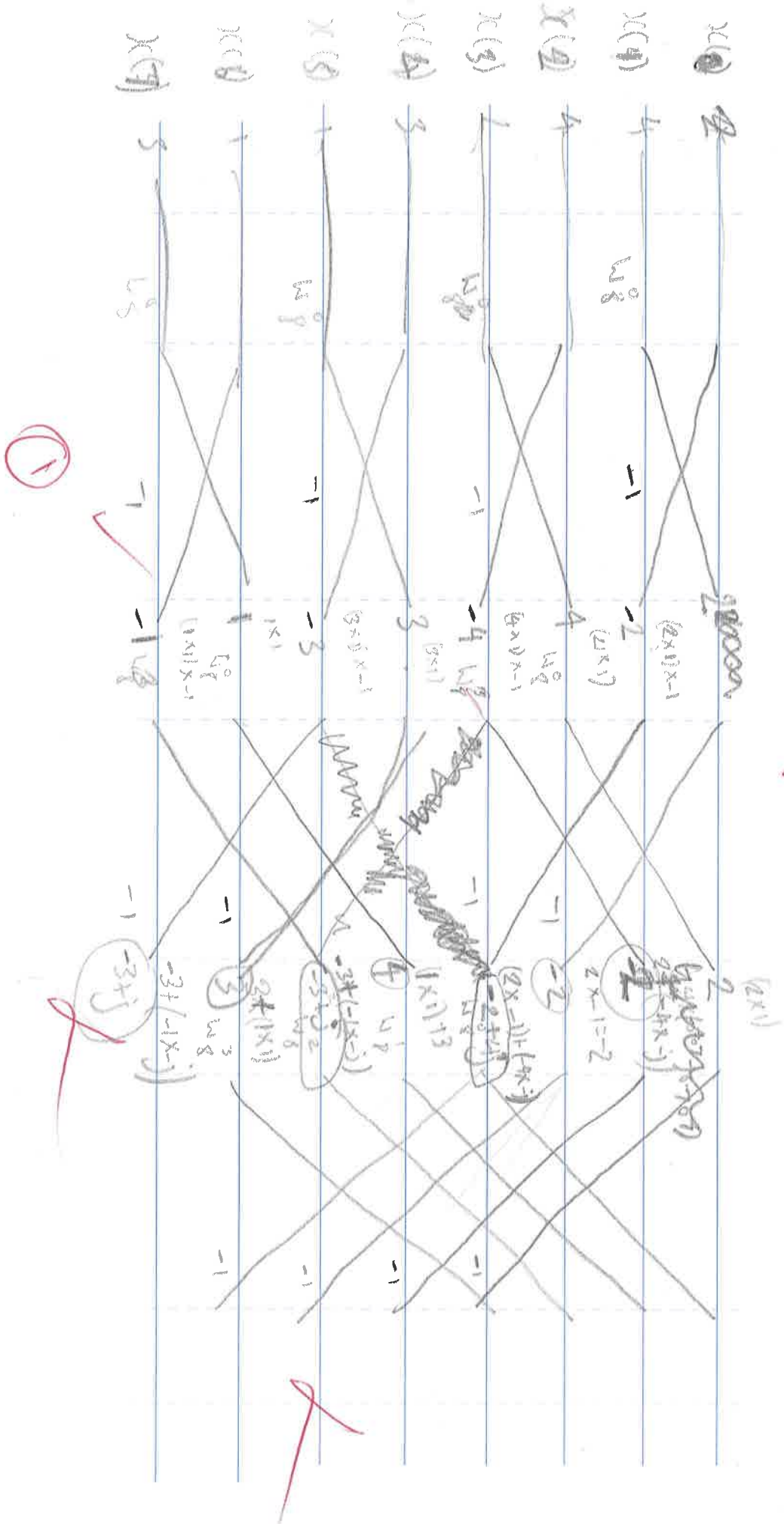
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Examiner Only

Question No.

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