QUIZ - 1 Solutions

(1) Solved in Tutorial 2

(2) (a) WKT, Symbol rate $= \frac{R}{\log_2 m}$

and we use BW $\propto$ Symbol rate

5 Hz needed for symbol rate = 1 symbols/sec

15 MHz needed for symbol rate = x symbols/sec

$$x = \frac{15\,MHz}{5\,Hz} = 3M \text{ symbols/sec}$$

[new symbol rate]

Also, required $R = 30$ Mbps

$$\therefore 3M \text{ symbols/sec} = \frac{30\,Mbps}{\log_2 m}$$

$$\therefore m = 2^{10} = 1024$$

(b) WKT, $x(t) = \sum_n b(n)\, p(t - nT)$

New symbol rate $= \frac{1}{T} = 3 \times 10^6$

New pulse $g(t) = p\left(\frac{t}{T}\right)$

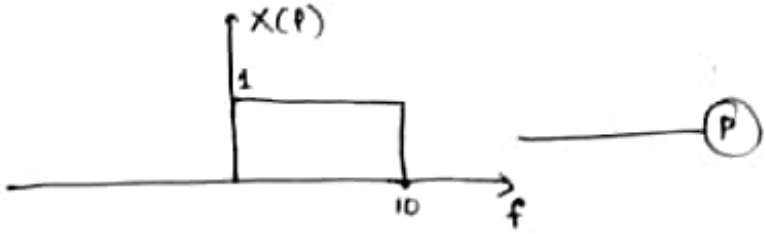
$$\therefore g(t - nT) = p\left(\frac{t - nT}{T}\right)$$

$$= p\left(\frac{t}{T} - n\right)$$

$$x(t) = \sum_n b(n)\, g(t - nT)$$

$$= \sum_n b(n)\, p\left(\frac{t}{T} - n\right)$$

3) $X(f) = \begin{cases} 1 ; & 0 \le f \le 10 \\ 0 ; & o.w \end{cases}$



a) ~~$x_e(t) = \frac{x(t) + x^*(-t)}{2}$~~

$$X(f) = X_e(f) + jX_s(f) \quad \text{---(1)}$$

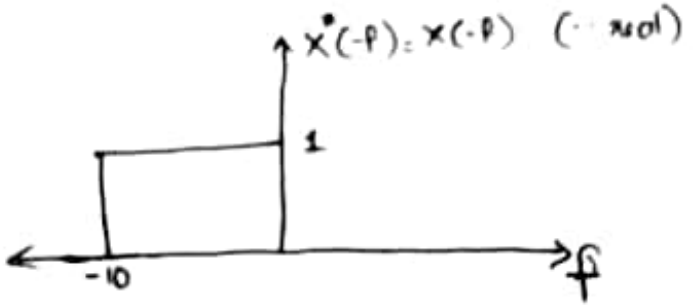
$$X^*(-f) = X_e^*(-f) - jX_s^*(-f) \quad \text{---(2)}$$

Since $x_e(t)$ & $x_s(t)$ are real, $X_e(f) = X_e^*(-f)$ &
$X_s(f) = X_s^*(-f)$

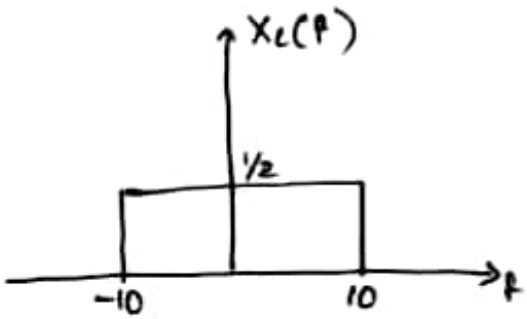
Hence from (1) & (2),

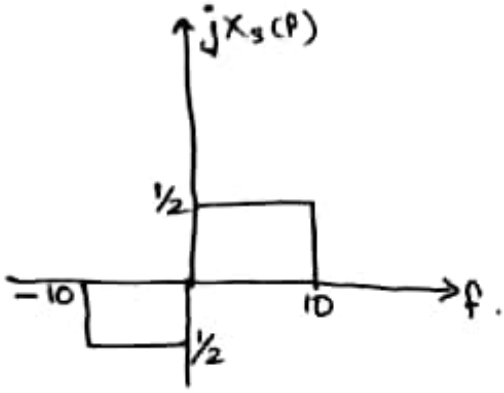
$$X_e(f) = \frac{X(f) + X^*(-f)}{2} \quad \text{---(R)}$$

$$X_s(f) = \frac{X(f) - X^*(-f)}{2j}$$



P →





b) Comparing spectrum of $X(f)$ & $U_p(f)$,

$$U_p(f) = -2X(f-90) + 2X(f-100) - 2X(f+100) + 2X(f+110)$$

$$\Rightarrow u_p(t) = -2x(t)e^{j2\pi 90t} + 2x(t)e^{j2\pi 100t} - 2x(t)e^{-j2\pi 100t} + 2x(t)e^{-j2\pi 110t}$$

$$= 2x(t)\left[e^{-j2\pi 110t} - e^{j2\pi 90t}\right] + 2x(t)\left[e^{j2\pi 100t} - e^{-j2\pi 100t}\right]$$

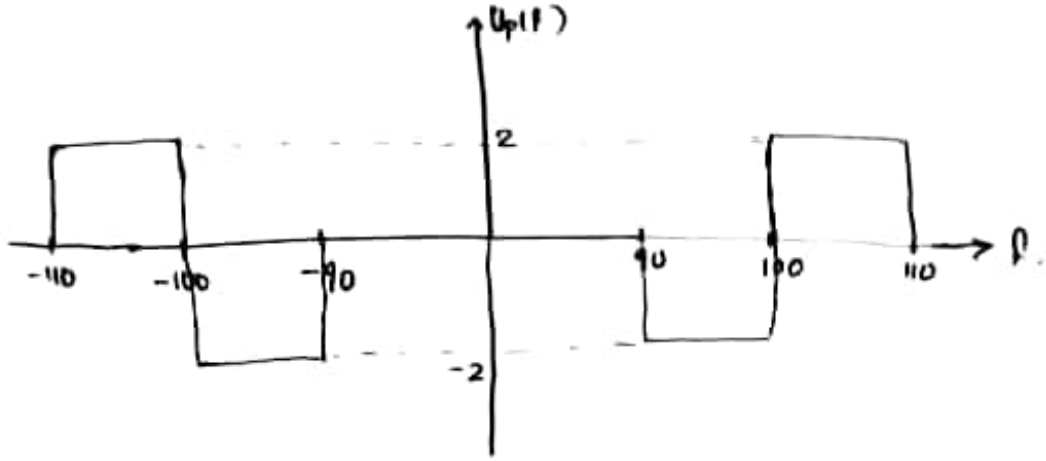
$$= 2x(t)\cdot e^{-j2\pi 10t}\cdot \underbrace{\left[e^{-j2\pi 100t} - e^{+j2\pi 100t}\right]}_{-2j\sin(2\pi 100t)} + 2x(t)\cdot 2j\sin(2\pi 100t)$$

$$= 4j\,x(t)\cdot \sin 2\pi 100t \cdot \underbrace{\left[1 - e^{-j2\pi 10t}\right]}_{e^{-j2\pi 5t}\, 2j\sin 2\pi 5t}$$

$$= 8j\,x(t)\cdot \cos 2\pi 5t \cdot \sin 2\pi 100t \cdot e^{-j2\pi 5t}$$

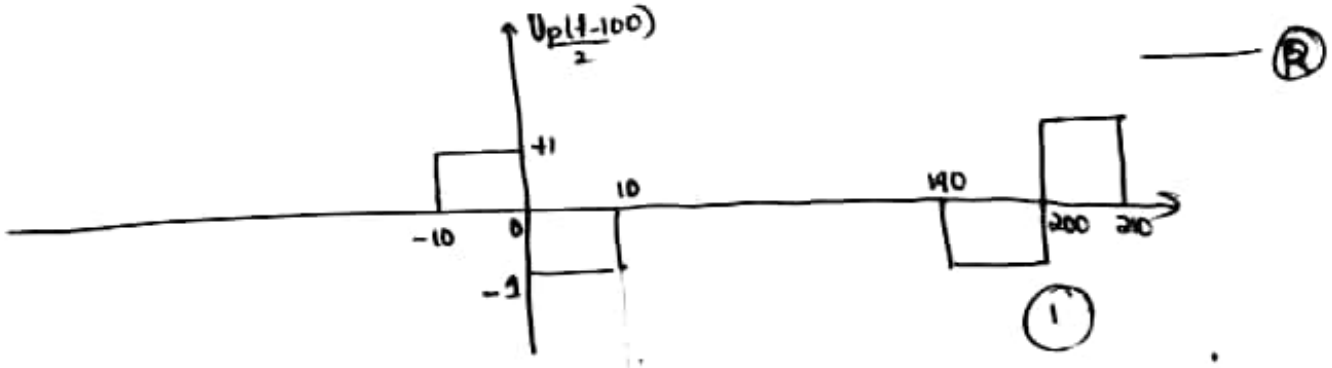
$$= -8x(t)\cdot \sin(2\pi 5t)\cdot \sin(2\pi 100t)\cdot e^{-j2\pi 5t}$$

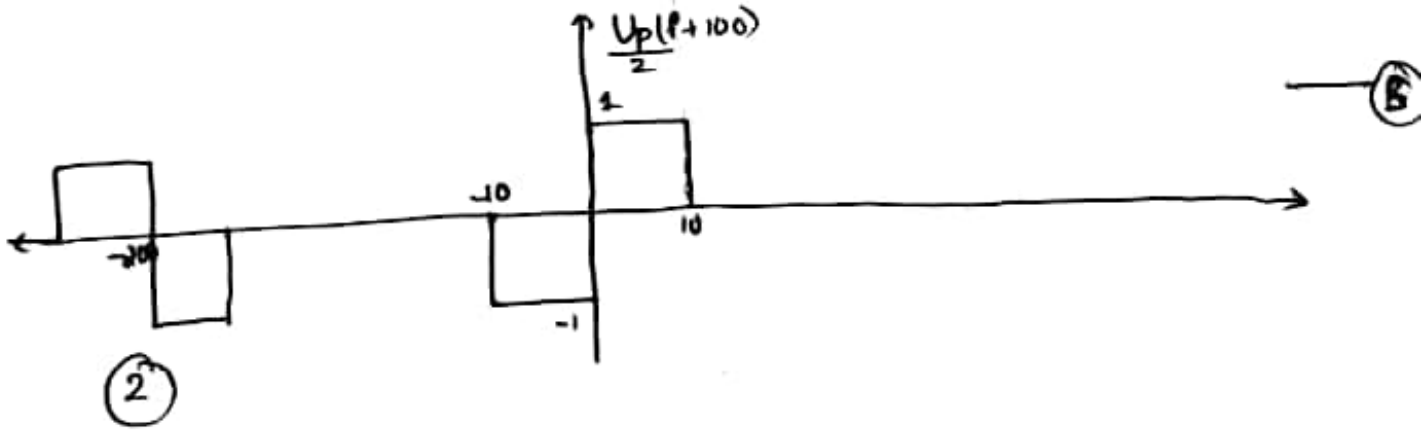
9)



$$u_p(t)\cos 200\pi t \xrightarrow{\mathcal{F}} U_p(f) * \frac{[\delta(f+100) + \delta(f-100)]}{2}$$

$$= \frac{U_p(f+100)}{2} + \frac{U_p(f-100)}{2}$$





(B) + (R) → LPF f_c = 20Hz →

- copies (1) & (2) will be eliminated
- The signals within -20Hz to 20Hz cancels out.

So $y_p = 0$