6-12

$$a_n \frac{d^n y}{dt^n} + a_{n-1} \frac{d^{n-1} y}{dt^{n-1}} + \cdots + a_0 y = b_m \frac{d^m x}{dt^m} + b_{m-1} \frac{d^{m-1} x}{dt^{m-1}} + \cdots + b_0 x$$

Transforming by assuming zero initial conditions

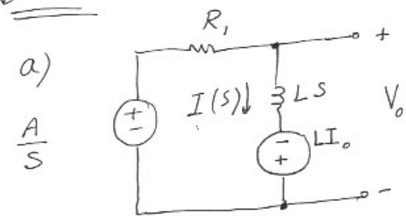
$\Downarrow$

$$a_n s^n Y(s) + a_{n-1} s^{n-1} Y(s) + \cdots + a_0 Y(s) = b_m s^m X(s) + b_{m-1} s^{m-1} X(s) + b_0 X(s)$$

$$\therefore H(s) = \frac{Y(s)}{X(s)} = \frac{b_m s^m + b_{m-1} s^{m-1} + \cdots + b_0}{a_n s^n + a_{n-1} s^{n-1} + \cdots + a_0}$$

6-14

a)



$$\frac{A}{s} = R_1 I(s) + LSI(s) - LI_o$$

$$I(s) = \left(\frac{A}{s} + LI_o\right) / (R_1 + LS)$$

$$I(s) = \frac{A + LSI_o}{s(R_1 + LS)} = \frac{\frac{A}{L} + sI_o}{s\left(s + \frac{R_1}{L}\right)} = \frac{A/R_1}{s} + \frac{I_o - \frac{A}{R_1}}{s + \frac{R_1}{L}}$$

$$\therefore i(t) = \frac{A}{R_1} u(t) + \left(I_o - \frac{A}{R_1}\right) e^{-\frac{R_1}{L} t} u(t)$$

b) $$i(t) = \underbrace{I_o e^{-\frac{R_1}{L} t} u(t)}_{\text{Zero input response}} + \underbrace{\left[\frac{A}{R_1} - \frac{A}{R_1} e^{-\frac{R_1}{L} t}\right] u(t)}_{\text{Zero State response}}$$

8-1

$$X_s(f) = f_s \sum_{n=-\infty}^{\infty} X(f - n f_s) \qquad (8-16)$$

f_s = sampling frequency.

$X(f)$ = Fourier transform of the the continuous signal $x(t)$

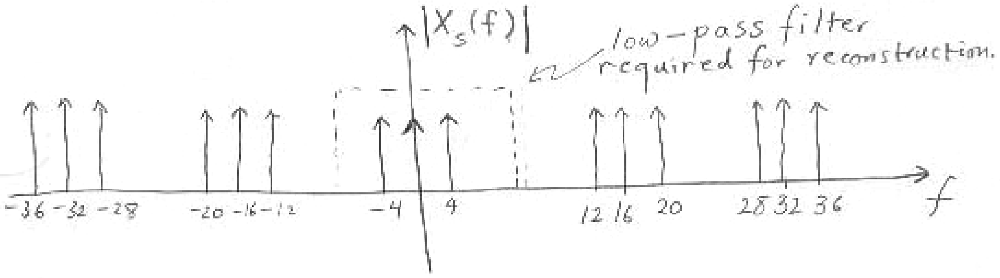
$X_s(f)$ = Fourier transform of the sampled signal $x_s(t)$.

$x(t) = 4 + 8 \cos 8\pi t$

$$X(f) = 4\delta(f) + 4\delta(f-4) + 4\delta(f+4)$$

$$X_s(f) = 16 \sum_{n=-\infty}^{\infty} \left[4\delta(f-16n) + 4\delta(f-16n-4) + 4\delta(f-16n+4) \right]$$

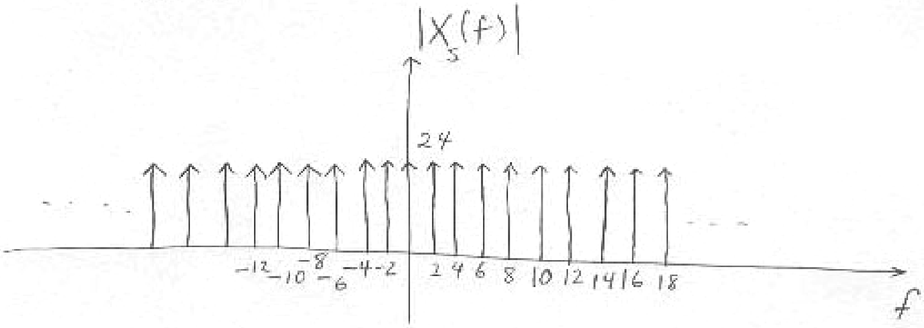
$$= 64 \sum_{n=-\infty}^{\infty} \left[\delta(f-16n) + \delta(f-16n-4) + \delta(f-16n+4) \right]$$



8-2

$$X_s(f) = 6 \sum_{n=-\infty}^{\infty} \Big[4\delta(f-6n) + 4\delta(f-6n-4) + 4\delta(f-6n+4) \Big]$$

$$= 24 \sum_{n=-\infty}^{\infty} \Big[\delta(f-6n) + \delta(f-6n-4) + \delta(f-6n+4) \Big]$$



Original signal cannot be recovered, since

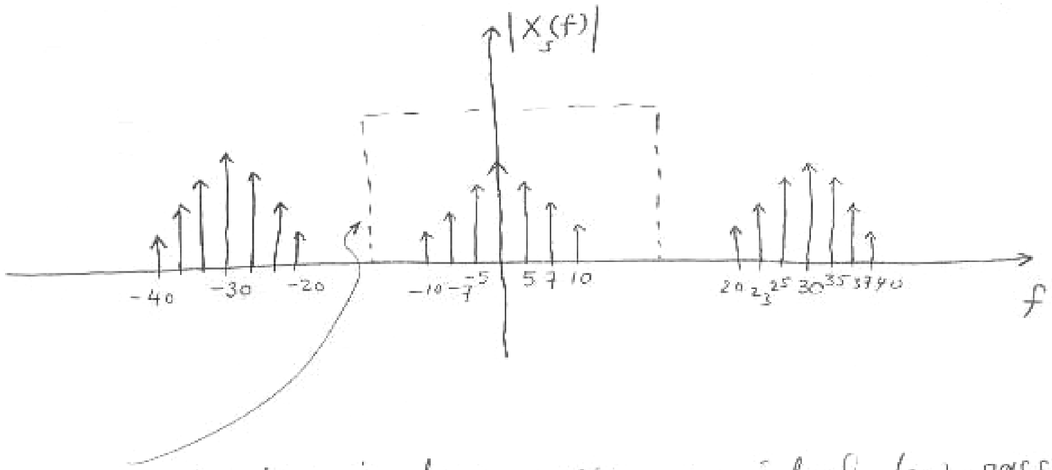
$f_s < 2f_H$ $\left(\text{i.e. } f_s = 6 < 2 f_H = 2 \times 4 \right)$
$(6 < 8)$

8-3

$$X(f) = 3\delta(f) + 2\delta(f-5) + 2\delta(f+5) + 2.5\delta(f-7) + 2.5\delta(f+7) + \delta(f-10) + \delta(f+10)$$

$$X_s(f) = 30 \sum_{n=-\infty}^{\infty} \Big[3\delta(f-nf_s) + 2\delta(f-nf_s-5) + 2\delta(f-nf_s+5) + 2.5\delta(f-nf_s-7) + 2.5\delta(f-nf_s+7) + \delta(f-nf_s-10) + \delta(f-nf_s+10) \Big]$$

$f_s = 30$ samples per second.



reconstruction is done using an ideal low-pass filter with cutoff frequency $10 < f_c < 20$.