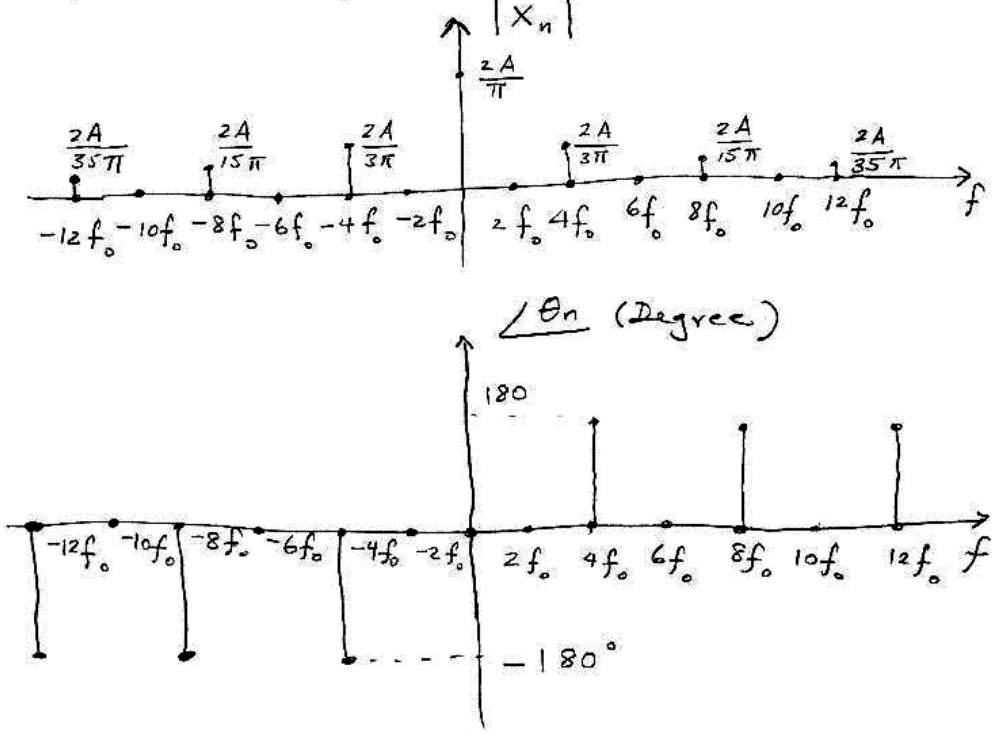
3-20

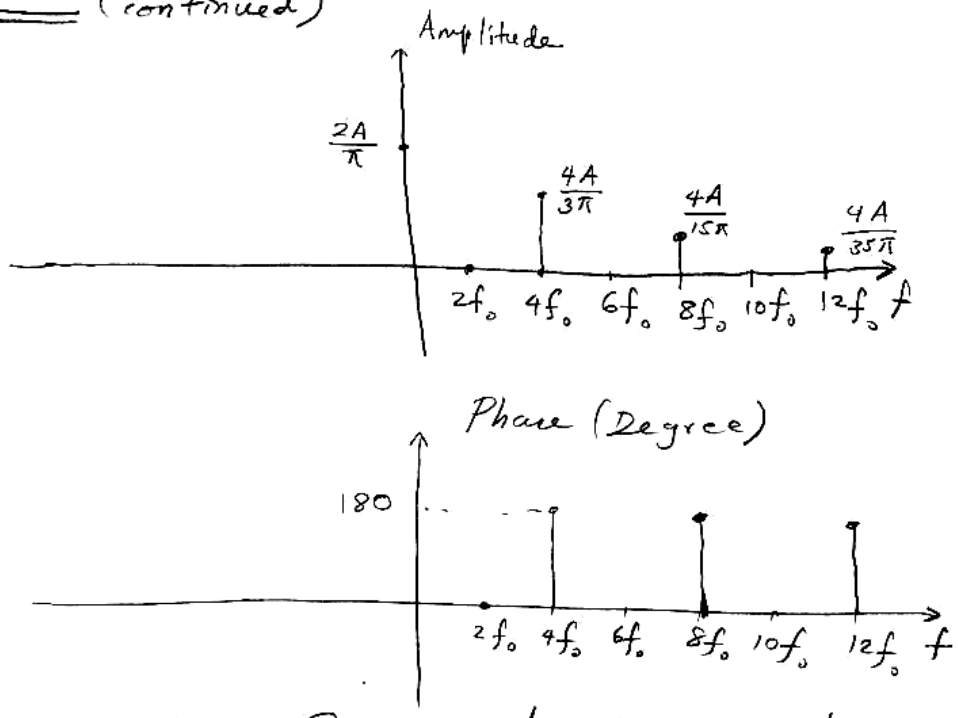
$$X_n = \begin{cases} \frac{2A}{\pi(1-n^2)} & , n \text{ even} \\ 0 & , n \text{ odd} \end{cases}$$

The fundamental frequency $= 1/(T_0/2) = 2f_0$.



Double-Sided Amplitude & Phase Spectra.

3-20 (continued)



Single - Sided Amplitude & Phase spectra.

3.22

a) Same as 3-11 a) with null spacing $= \frac{1}{\tau} = 500\,Hz$, and line spacing $= \frac{1}{T_0} = 125\,Hz$.

b) Same as 3-11 b) with null spacing $= \frac{1}{\tau} = 1000\,Hz$ and line spacing $= \frac{1}{T_0} = 125\,Hz$.

c) Same as 3-11 c) with null spacing $= \frac{1}{\tau} = 500\,Hz$ and line spacing $= \frac{1}{T_0} = 62.5\,Hz$.

4-1

a) $X_a(f) = \dfrac{A}{\alpha + j2\pi f}$

b) $X_b(f) = \dfrac{A}{\alpha - j2\pi f}$

c) $x_c(t) = Ae^{-\alpha|t|} = Ae^{-\alpha t}u(t) + Ae^{\alpha t}u(-t)$

$\therefore X_c(f) = \dfrac{A}{\alpha + j2\pi f} + \dfrac{A}{\alpha - j2\pi f} = \dfrac{2\alpha A}{\alpha^2 + 4\pi^2 f^2}$

or use pair 6, table 4-2 to obtain the same answer.

d) $X_d(f) = \dfrac{A}{\alpha + j2\pi f} - \dfrac{A}{\alpha - j2\pi f} = \dfrac{-j4\pi f\, A}{\alpha^2 + 4\pi^2 f^2}$

4-6

a) $X_a(f) = \int_0^\infty \underbrace{t}_{u}\underbrace{e^{-\alpha t}\, e^{-j2\pi f t}\, dt}_{dv} = uv\Big|_0^\infty - \int_0^\infty v\, du$

$= t\,\dfrac{e^{-(\alpha + j2\pi f)t}}{-(\alpha + j2\pi f)}\Big|_0^\infty - \int_0^\infty \dfrac{e^{-(\alpha + j2\pi f)t}}{-(\alpha + j2\pi f)}\, dt$

$= 0 - 0 + \dfrac{1}{(\alpha + j2\pi f)}\,\dfrac{e^{-(\alpha + j2\pi f)t}}{-(\alpha + j2\pi f)}\Big|_0^\infty$

$= \dfrac{1}{(\alpha + j2\pi f)^2}$

b) $X_b(f) = \int_{-\infty}^{\infty} t^2 u(t) u(1-t) e^{-j2\pi ft} dt$

$= \int_0^1 t^2 e^{-j2\pi ft} dt$, Let $u = t^2$, $dV = e^{-j2\pi ft} dt$

$= uv\Big|_0^1 - \int_0^1 v\, du$

$= t^2 \frac{e^{-j2\pi ft}}{-j2\pi f}\Big|_0^1 - \int_0^1 \frac{e^{-j2\pi ft}}{-j2\pi f} 2t\, dt$

$= \frac{e^{-j2\pi f}}{-j2\pi f} + \frac{1}{j\pi f} \int_0^1 \underbrace{t}_{u} \underbrace{e^{-j2\pi ft} dt}_{dv}$

$= \frac{e^{-j2\pi f}}{-j2\pi f} + \frac{1}{j\pi f} \left[t \frac{e^{-j2\pi ft}}{-j2\pi f}\Big|_0^1 - \int_0^1 \frac{e^{-j2\pi ft}}{-j2\pi f} dt \right]$

$= \frac{e^{-j2\pi f}}{-j2\pi f} + \frac{e^{-j2\pi f}}{2\pi^2 f^2} - \frac{1}{2\pi^2 f^2} \frac{e^{-j2\pi ft}}{-j2\pi f}\Big|_0^1$

$= \frac{e^{-j2\pi f}}{-j2\pi f} + \frac{e^{-j2\pi f}}{2\pi^2 f^2} + \frac{e^{-j2\pi f}}{j4\pi^3 f^3} - \frac{1}{j4\pi^3 f^3}$

c)

$$X_c(f) = \int_0^1 e^{-\alpha t} e^{-j2\pi f t}\, dt$$

$$= \frac{e^{-(\alpha + j2\pi f)t}}{-(\alpha + j2\pi f)}\Bigg|_0^1 = \frac{e^{-(\alpha + j2\pi f)} - 1}{-(\alpha + j2\pi f)}$$

$$= \frac{1 - e^{-(\alpha + j2\pi f)}}{(\alpha + j2\pi f)}$$