APPENDIX F

TABLE OF SAMPLED DESCRIBING FUNCTIONS

$$x(t) = A \sin\left(\frac{1}{n}\omega_s t + \phi\right)$$

ω_s = sampling frequency

Note: The relay with or without hysteresis (two-level switch) can be treated simply by the method of Sec. 9.1. This table gives sampled describing functions for the relay with dead zone and the linear, lead pulse-width modulator.

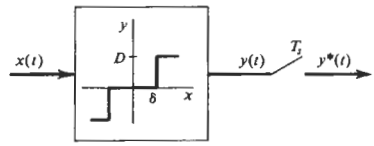

Figure F.1 *Sampled describing function for the relay with dead zone nonlinearity (cf. Sec. 9.2).*

$N(A,\phi)$ = sampled describing function
= amplitude and phase relation between the sinusoid $x(t)$ and the fundamental harmonic component of $y^*(t)$

$N^*(A,\phi)$ = z-transform describing function

$$= \left.\frac{z \text{ transform of } y^*(t)}{z \text{ transform of } x(t)}\right|_{z=\exp(j\omega_s T_s/n)}$$

$$N^*(A,\phi) = T_s N(A,\phi)$$

This figure, in 7 parts, consists of plots of extreme values of $-1/N(A,\phi)$ for $n = 2,3,\ldots,8$. Only the unbiased output modes are included as they are the only modes of interest in the case of an unbiased input $x(t)$ (see Sec. 9.2).

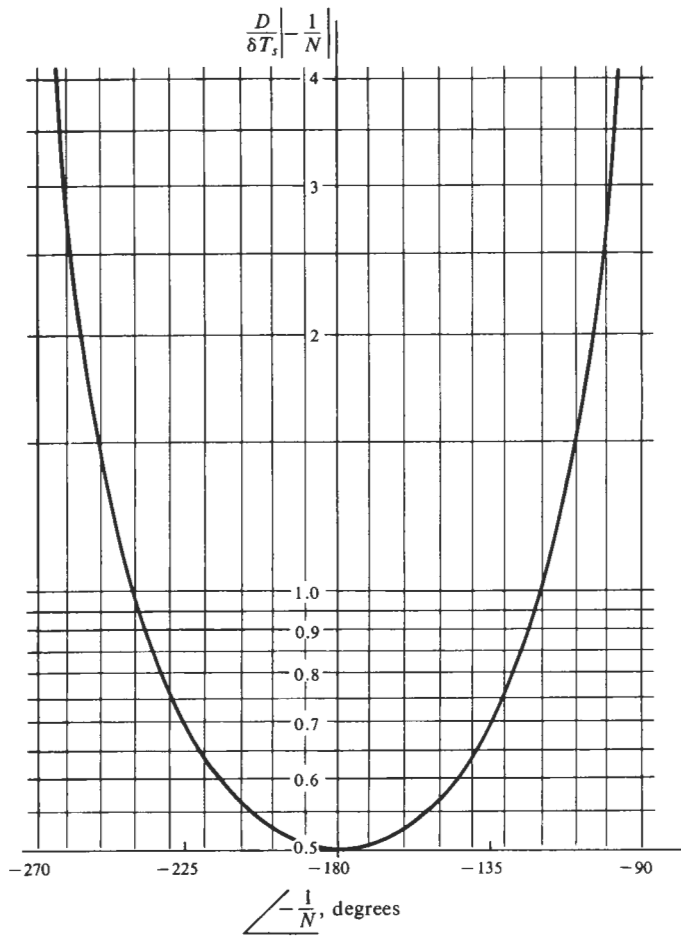

Figure F-1a $T = 2T_s$

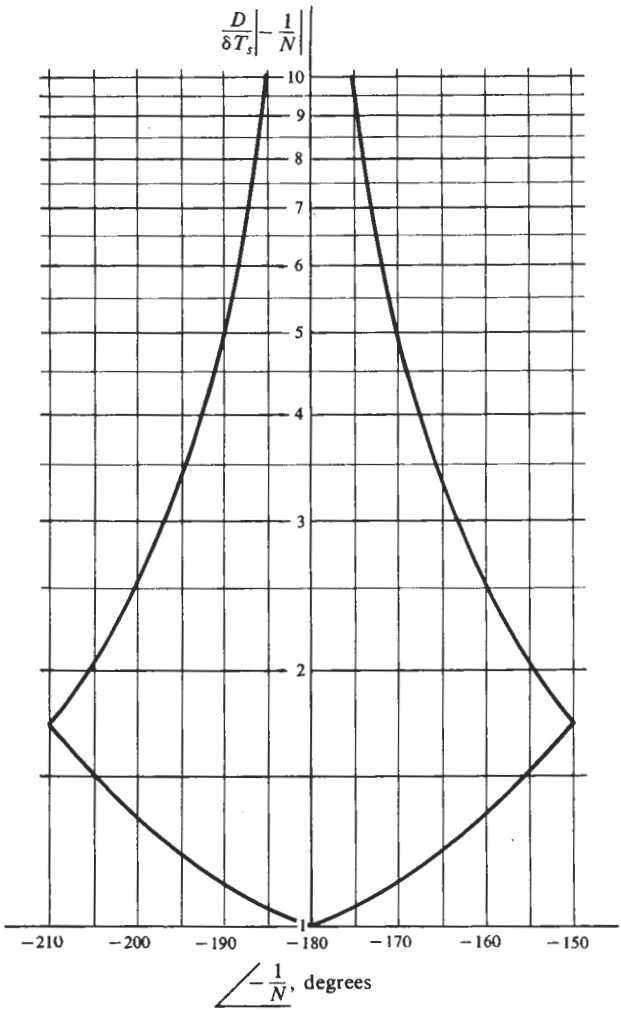

Figure F-1b $T = 3T_s$

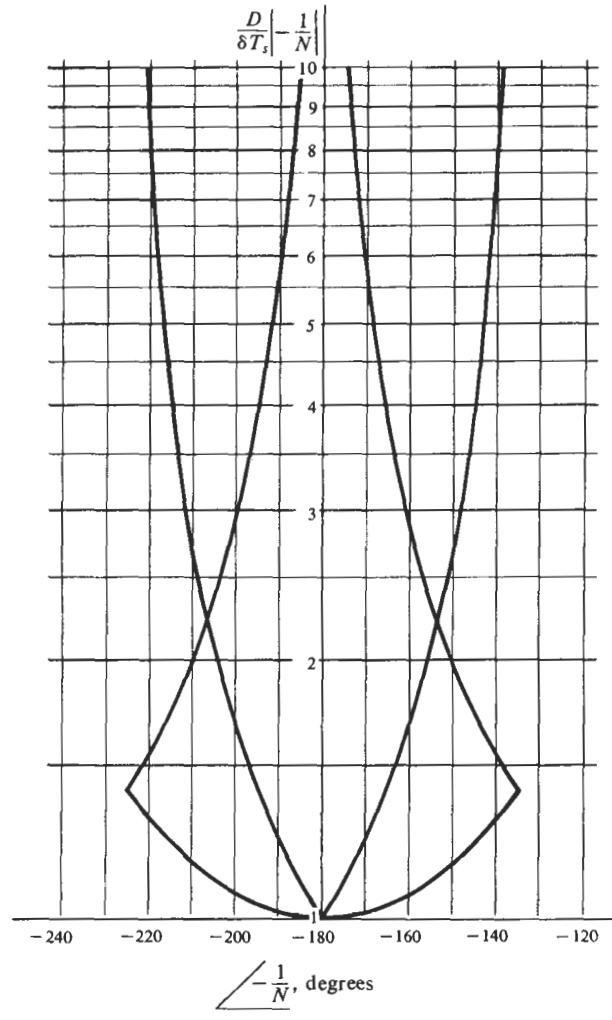

Figure F-1c $T = 4T_s$

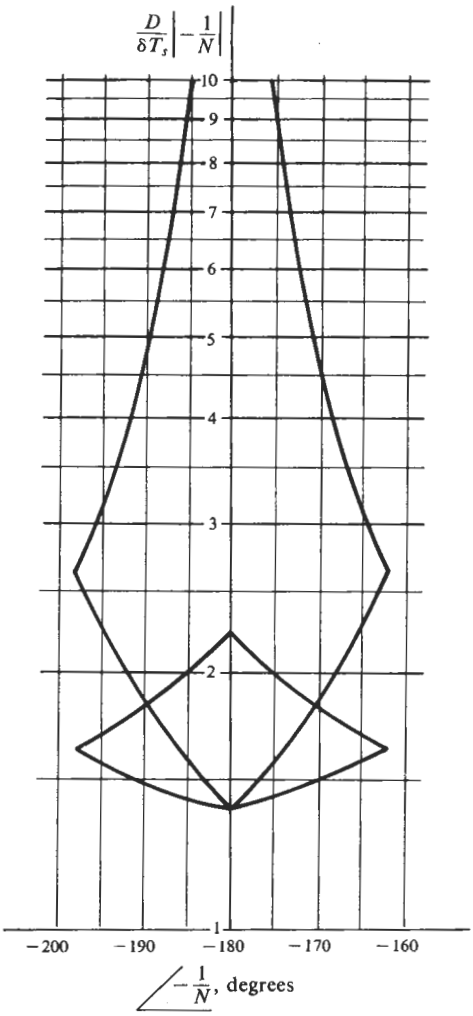

Figure F-1d $T = 5T_s$

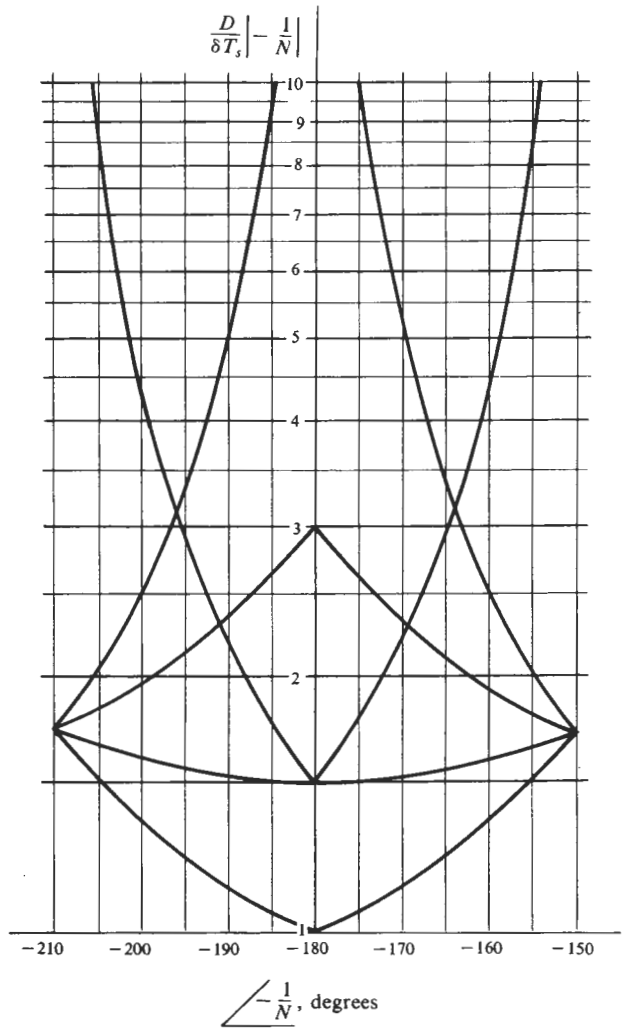

Figure F-1e $T = 6T_s$

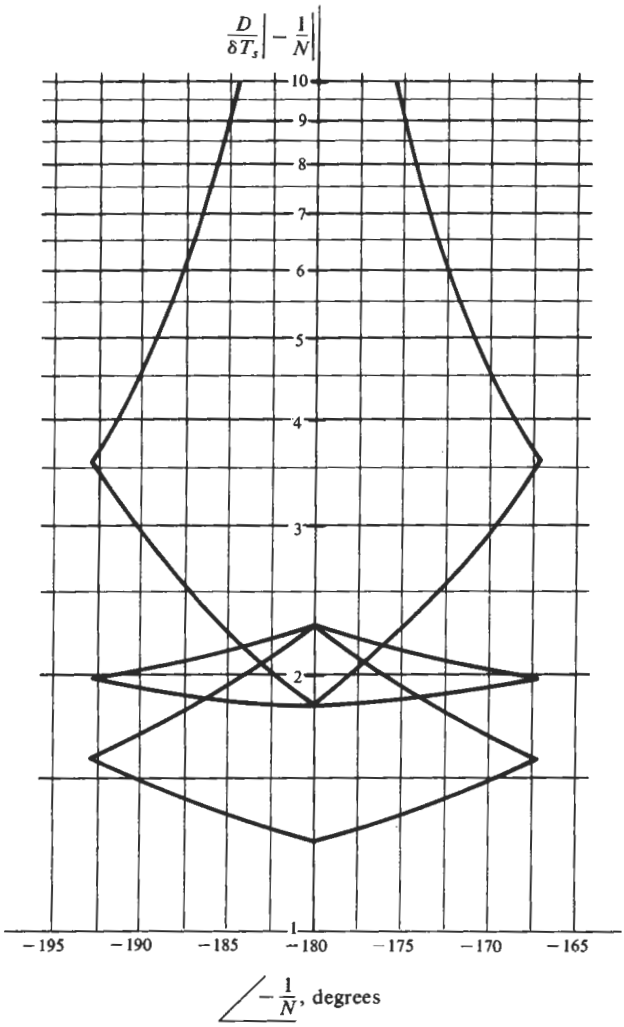

Figure F-1f $T = 7T_s$

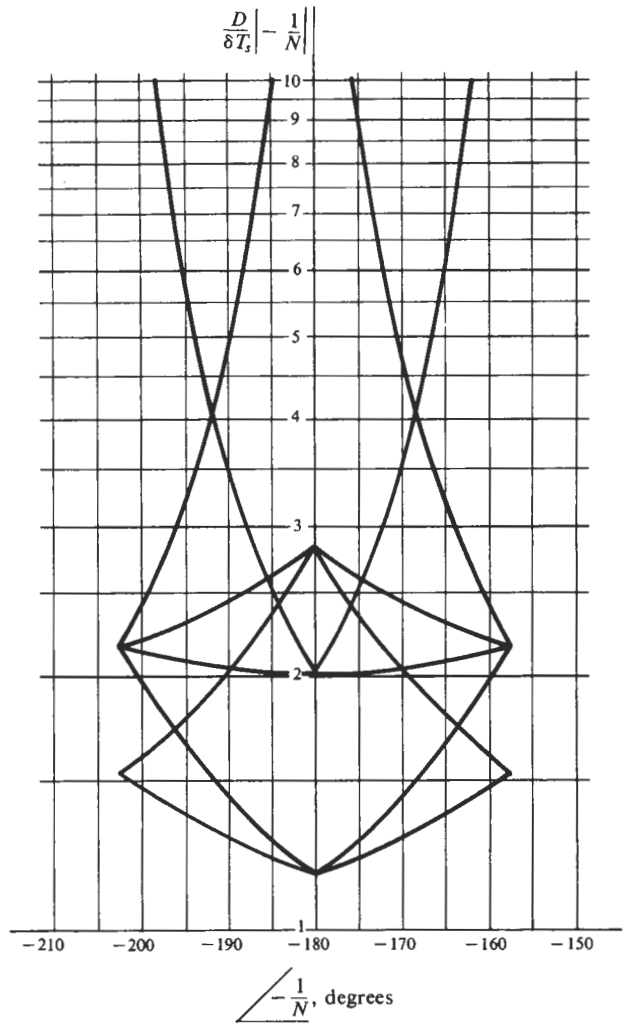

Figure F-1g $T = 8T_s$

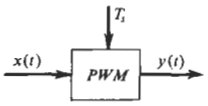

Figure F.2 Describing function for the linear, lead pulse-width modulator (cf. Sec. 9.5).

The operation of the *PWM* is defined by Eqs. (9.5–1,2), and is pictured in Fig. 9.5-1.

The describing function $N(A,\phi)$ is the usual amplitude and phase relation between the sinusoid $x(t)$ and the fundamental harmonic component of $y(t)$.

This figure, in 4 parts, consists of plots of $-1/N(A,\phi)$ for $n = 2, 4, 6, 8$ and a range of values of both A and ϕ. The solid curves correspond to constant values of A, and various values of ϕ are indicated. At other locations within the envelope of these curves, $-1/N(A,\phi)$ exists for other values of A and ϕ not shown.

The limiting values of these describing functions are

$$\lim_{A\to 0}\left(-\frac{Dk}{T_s}\frac{1}{N}\right) = \frac{1}{2\sin\phi}\underline{/\phi - 270^\circ} \qquad n = 2$$

$$= 1\underline{/-180^\circ} \qquad n > 2$$

$$\lim_{A\to\infty}\left(-\frac{Dk}{T_s}\frac{1}{N}\right) = \frac{\pi}{4}\frac{kA}{T_s}\underline{/\phi - 180^\circ} \qquad \text{all } n$$

where in each case ϕ may take any value in the range

$$0 < \phi < \frac{360}{n}$$

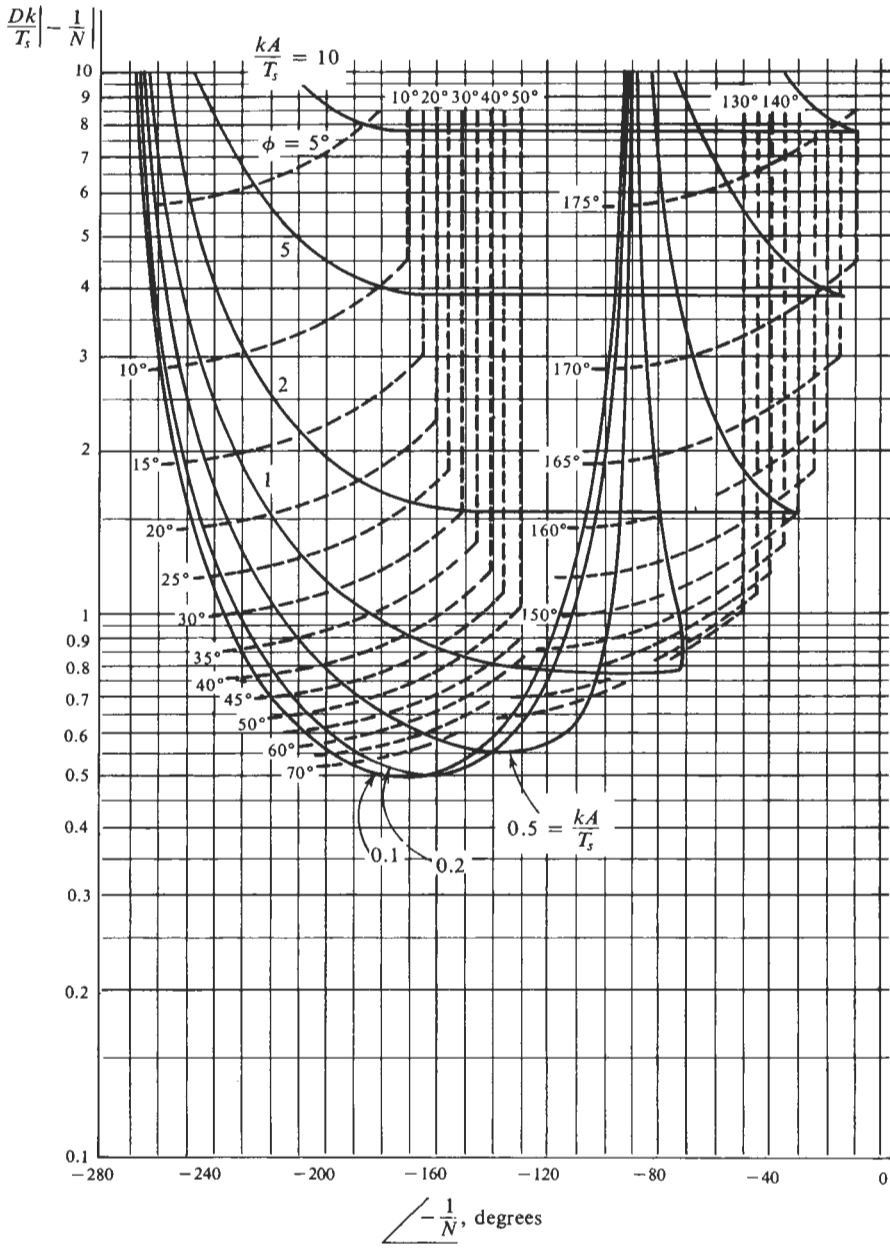

Figure F-2a $T = 2T_s$

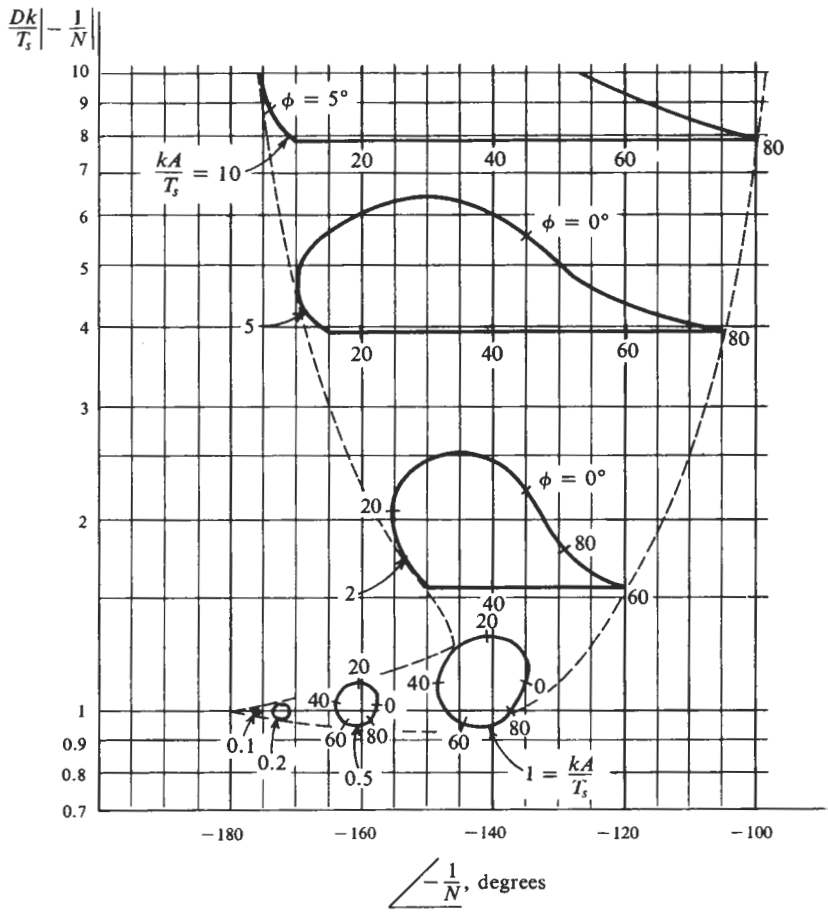

Figure F-2b $T = 4T_s$

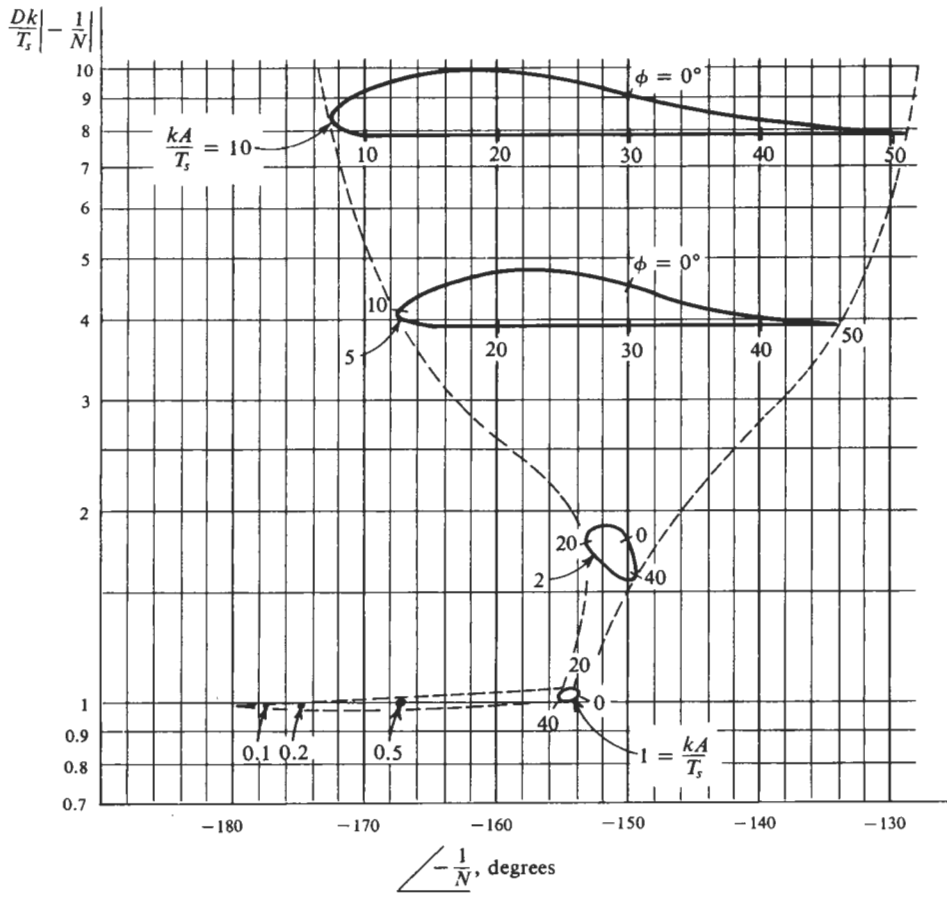

Figure F-2c $T = 6T_s$

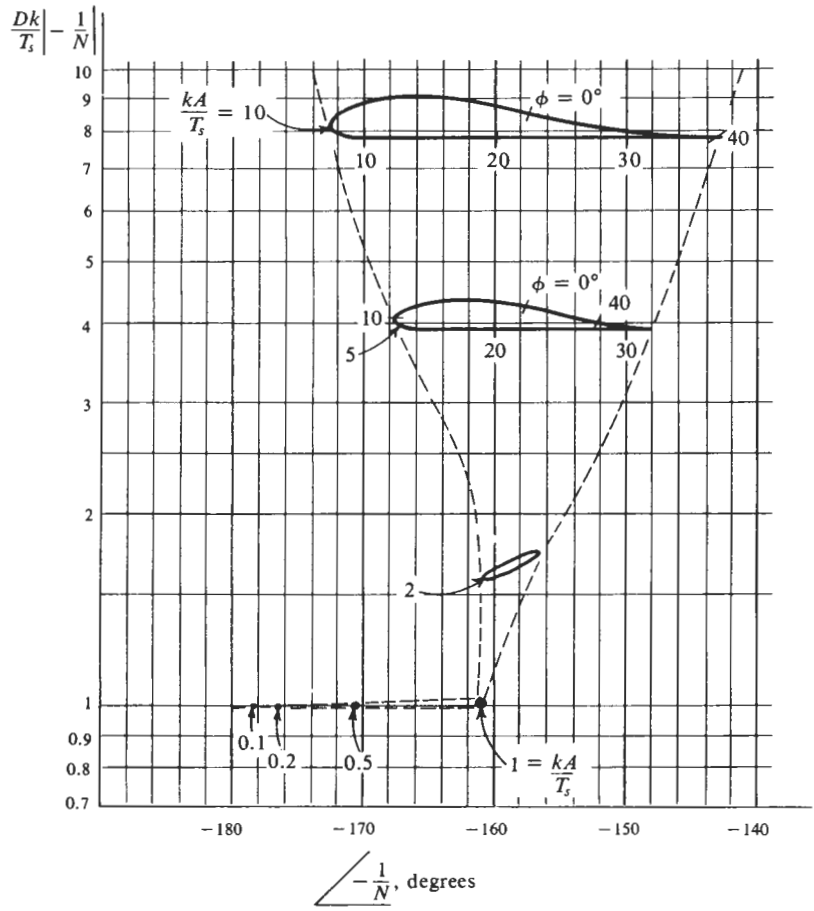

Figure F-2d $T = 8T_s$