First order system

$G(s) = \frac{k}{\tau s+1}$

By set s =jω

$|G| = \frac{k}{\sqrt{\tau^2\omega^2+1}}$

$\varphi = -\tan^{-1}\omega\tau$

$L = 20 \ \log MR$

L :log modulus

Analysis

$\log MR = \log k - \frac{1}{2}\log(\tau^2\omega^2 + 1) \qquad \ldots(1)$

$L = 20\log MR = 20\log k - 10\log(\tau^2\omega^2 + 1)$

$as\ \omega \to 0, L = 20\log k \cdots (2)$ low frequency asymptote, (LFA) and slope=0

$as\ \omega \to \infty, L = 20\log k - 10\log(\tau^2\omega^2 + 1)$

$\log(\tau^2\omega^2 + 1) = \log(\tau^2\omega^2)$

$L =\ 20\log k$-$20\log\tau - 20\log\omega \cdots (3)$

Straight line ,slope =-20 frequency asymptote ,(HFA)

HFA &LFA intersect each other at eq.(2)=eq.(3)

$20\log k = 20\log k$-$20\log\tau - 20\log\omega$

$\omega_c = \frac{1}{\tau}$ corner freq.

$\varphi = -\tan^{-1}\omega\tau - \tan^{-1}\frac{1}{\tau}$τ=-45°

$MR = \frac{k}{\sqrt{\frac{1}{\tau^2}\tau^2+1}} = \frac{k}{\sqrt{2}}$

$L = 20\log\frac{k}{\sqrt{2}} = 20\log k - 10\log 2$

$$L = 20\log\frac{k}{\sqrt{2}} = 20\log k - 3.0 \quad \cdots (4)$$

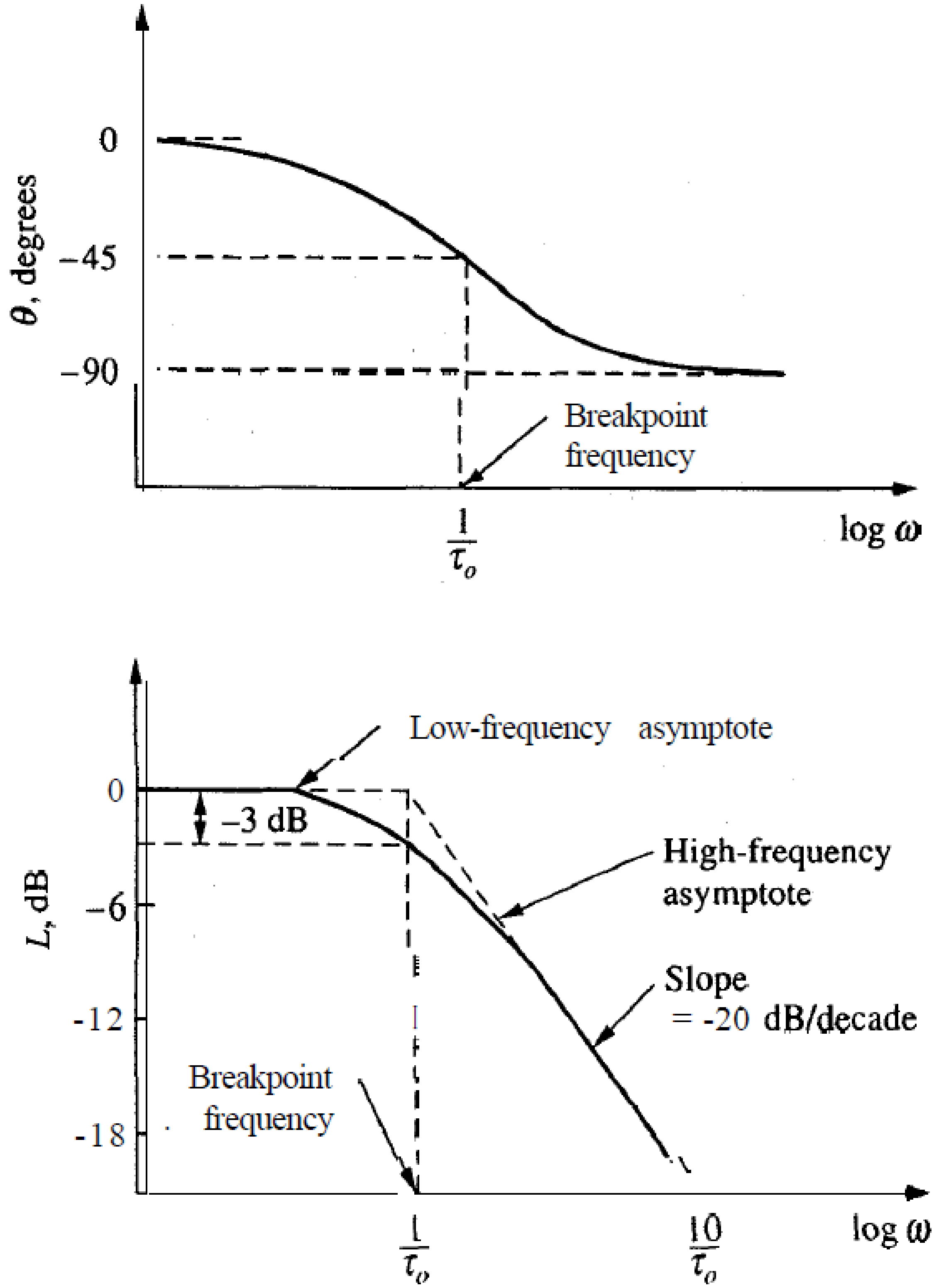

Fig. 53 Bode plots for first-order system