UNIT-5

(Lecture-7)

The Nichols Stability Method

The Nichols Stability Method

Polar Stability Plot - Nichols Mathcad Implementation

This example makes a polar plot of a transfer function and draws one contour of constant closed-loop magnitude. To draw the plot, enter a definition for the transfer function **G(s)**:

$$G(s) := \frac{45000}{s\cdot(s+2)\cdot(s+30)}$$

The frequency range defined by the next two equations provides a logarithmic frequency scale running from 1 to 100. You can change this range by editing the definitions for **m** and ω_m:

$$m := 0..100 \qquad \omega_m := 10^{.02\cdot m}$$

Now enter a value for **M** to define the closed-loop magnitude contour that will be plotted.

$$M := 1.1$$

Calculate the points on the M-circle:

$$MC_m := \left(\frac{-M^2}{M^2-1} + \left|\frac{M}{M^2-1}\right|\cdot\exp(2\cdot\pi\cdot j\cdot .01\cdot m)\right)$$

The first plot shows **G**, the contour of constant closed-loop magnitude **M**,

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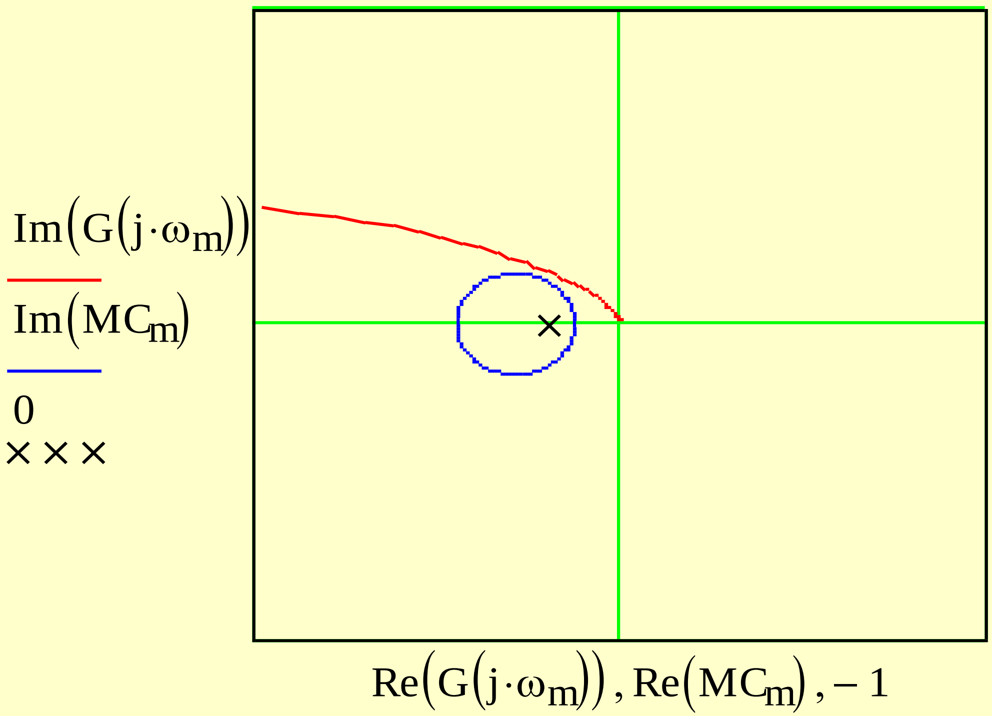
The first plot shows **G**, the contour of constant closed-loop magnitude **M**, and the Nyquist of the open loop system



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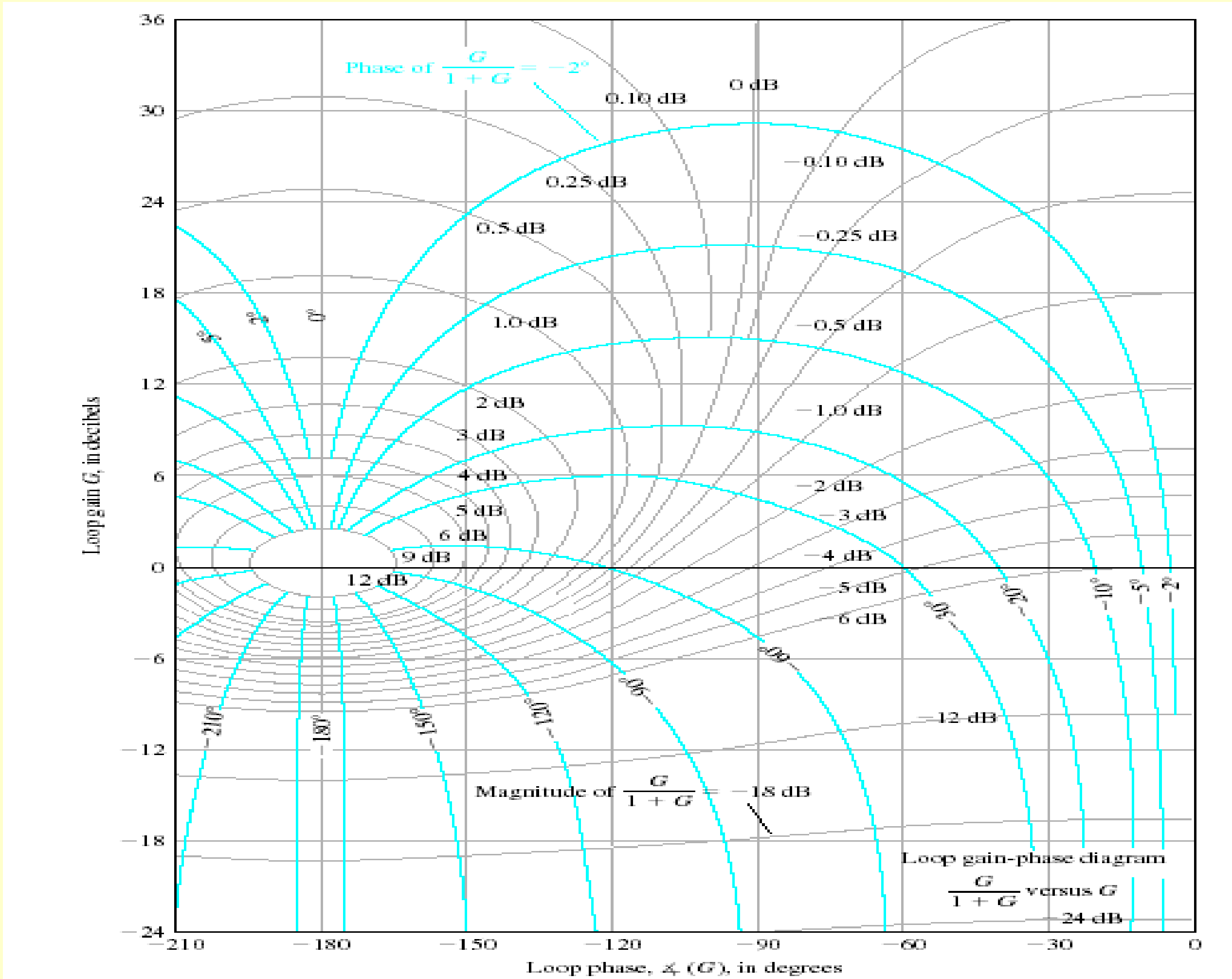

Nichols chart. The phase curves for the closed-loop system are shown in color.

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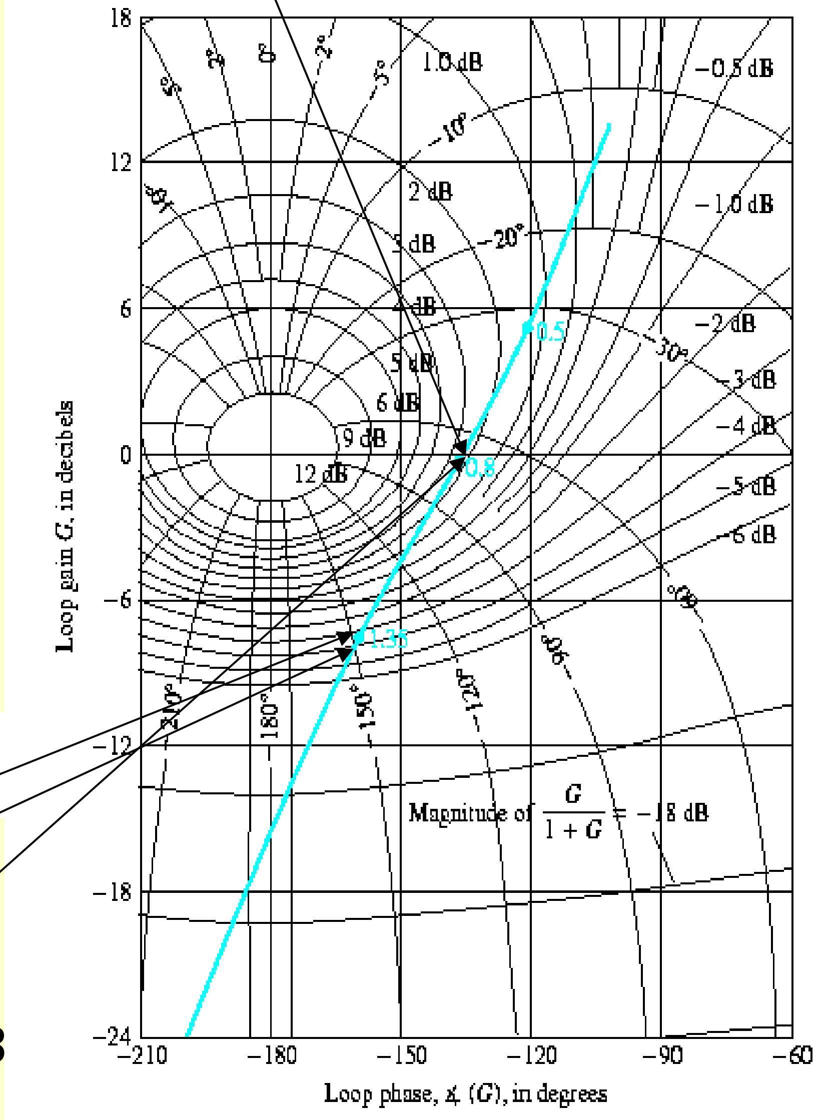
$$G(\omega) := \frac{1}{j\cdot\omega\cdot(j\cdot\omega + 1)\cdot(0.2\cdot j\cdot\omega + 1)}$$

$M_{pw} := 2.5$ dB $\omega_r := 0.8$

The closed-loop phase angle at ωr is equal to -72 degrees and ωb = 1.33
The closed-loop phase angle at ωb is equal tc
-142 degrees

Nichols diagram for $G(j\omega) = 1/j\omega(j\omega + 1)(0.2j\omega + 1)$. Three points on curve are shown for ω = 0.5, 0.8, and 1.35, respectively.



-3dB
-142 deg
-72 deg
wr=0.8

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$$G(\omega) := \frac{0.64}{j\cdot\omega\cdot\left[(j\cdot\omega)^2 + j\cdot\omega + 1\right]}$$

Phase Margin = 30 degrees

On the basis of the phase we estimate $\zeta := 0.30$

$M_{pw} := 9$ dB $\quad M_{pw} := 2.8 \quad \omega_r := 0.88$

From equation

$$M_{pw} = \frac{1}{2\cdot\zeta\cdot\sqrt{1-\zeta^2}} \qquad \zeta := 0.18$$

We are confronted with comflecting ζs

The apparent conflict is caused by the nature of G(jω) which slopes rapidally toward 180 degrees line from the 0-dB axis. The designer must use the frequency-domain-time-domain correlation with caution

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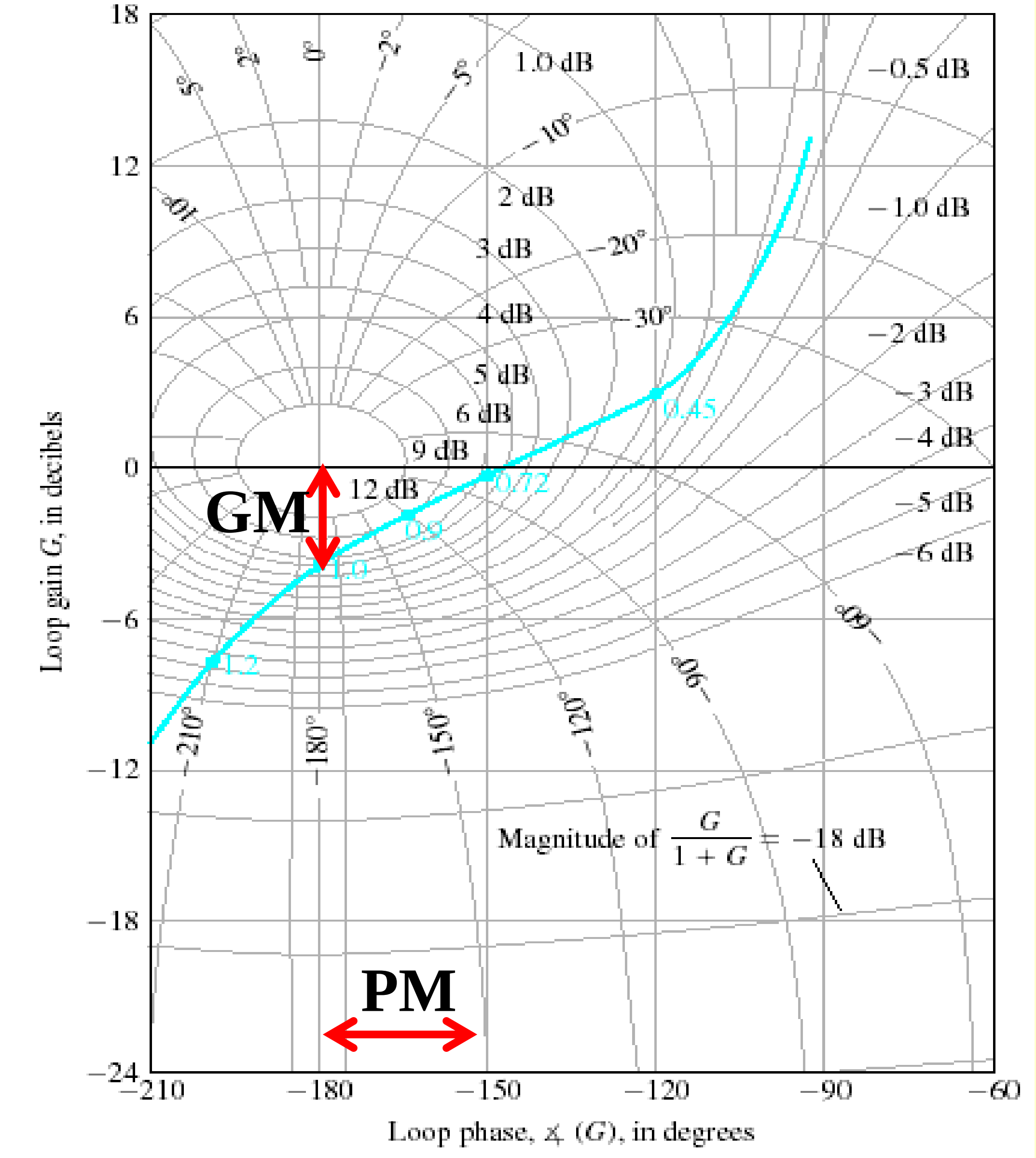

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