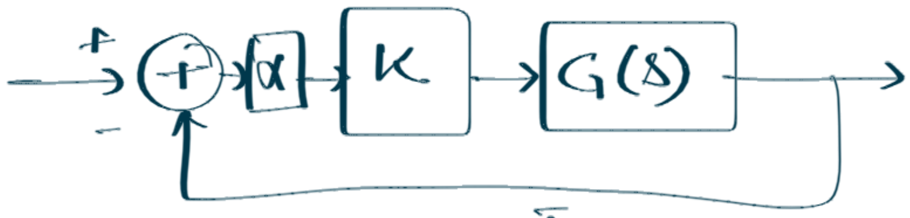
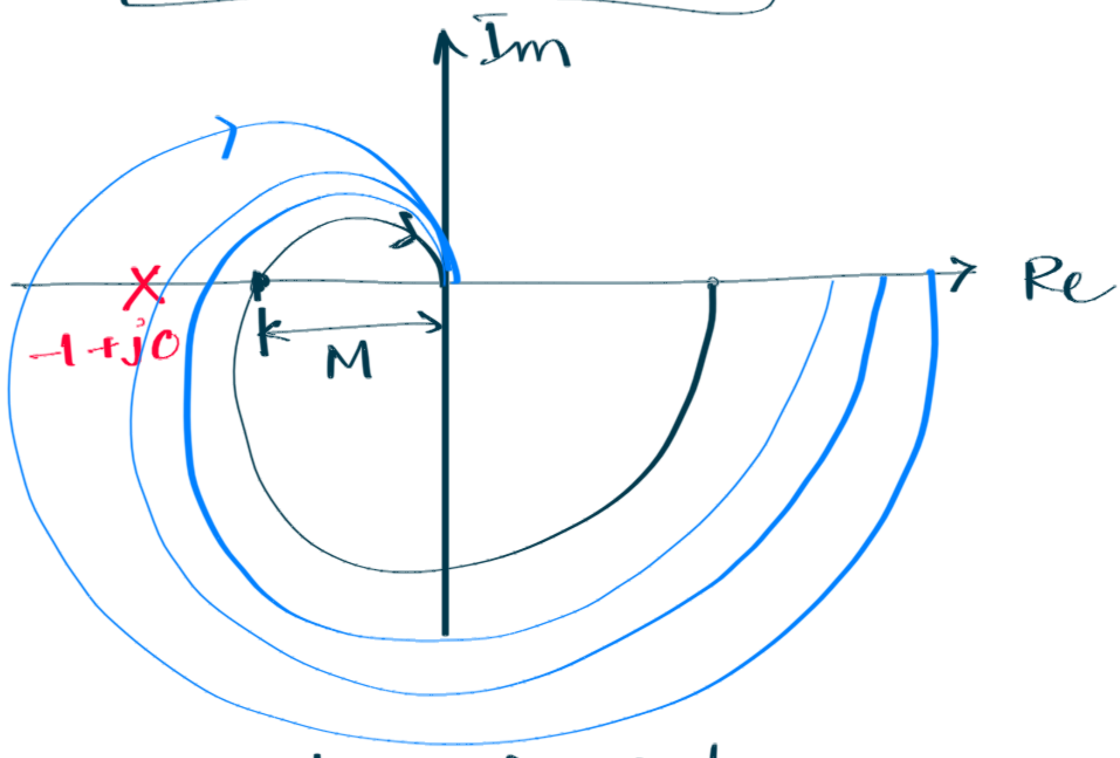
9 March:





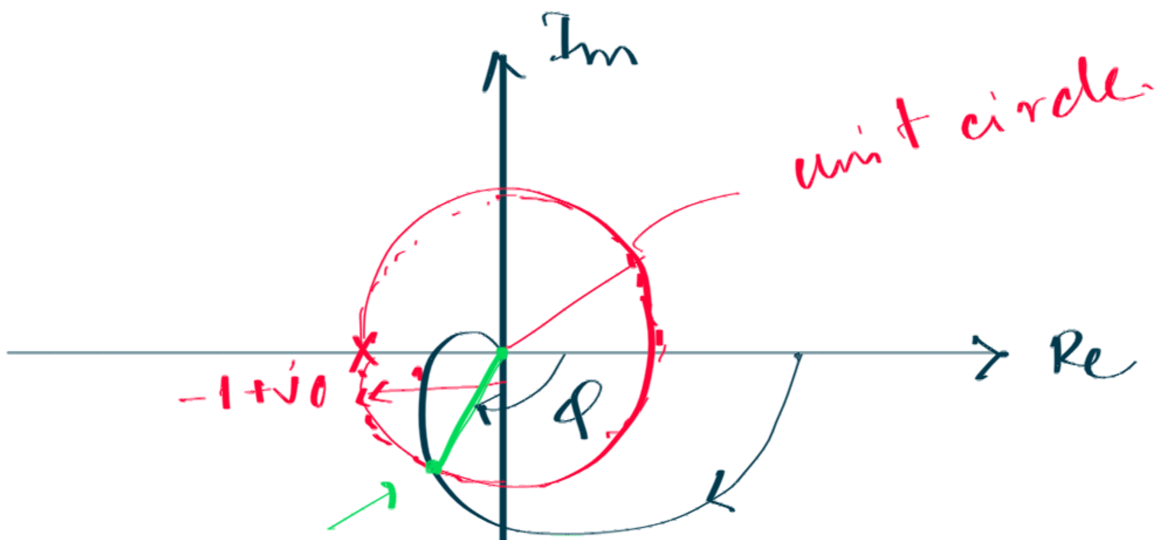
$M = |G(j\omega_p)|$

ω_p = the freq. at which phase becomes −180° for the first time

= PCF.

α = Gain margin := $\frac{1}{M}$.

$= -20\log_{10} M$ dB



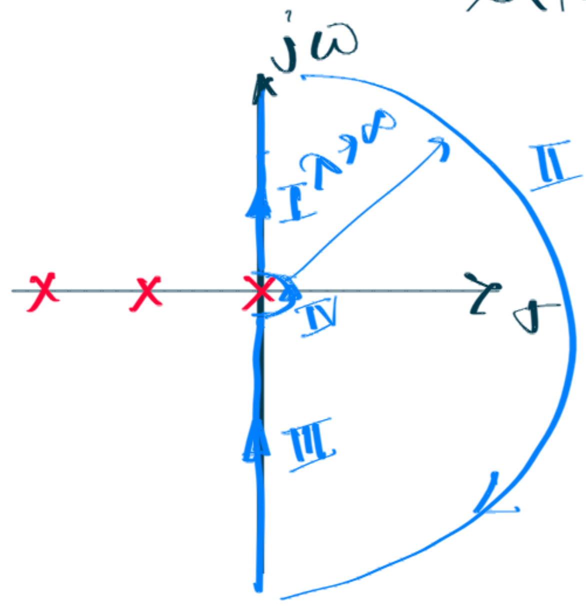
ω_g := Gain crossover freq.

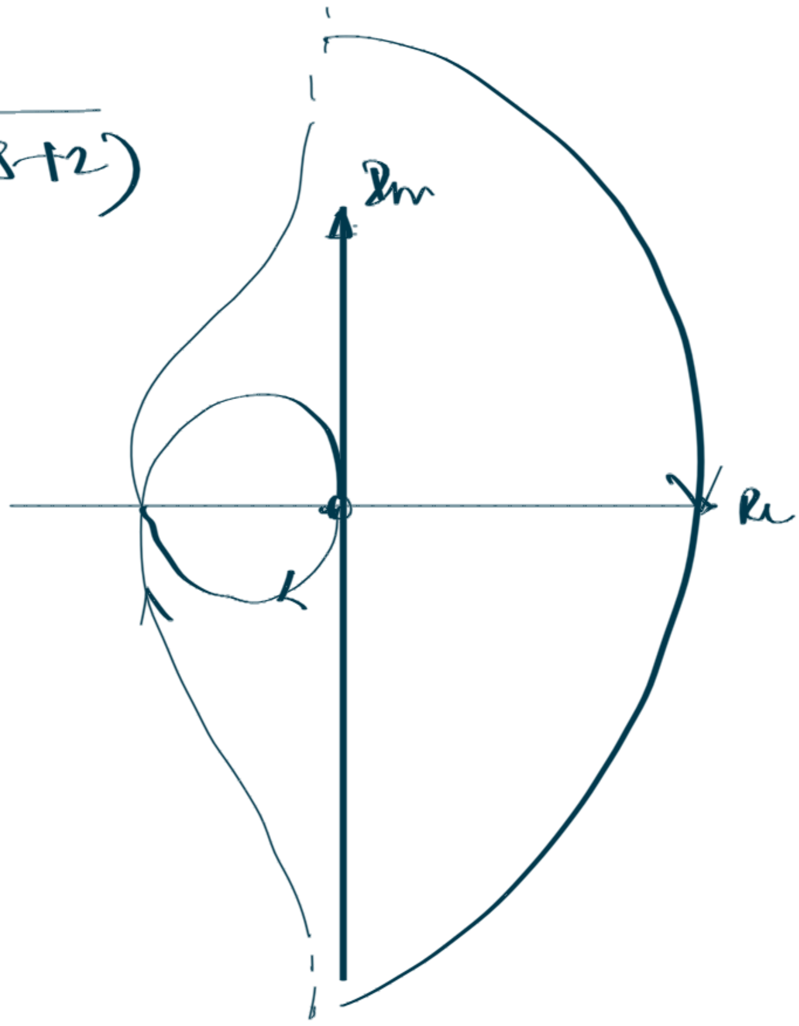
= freq. at which $G(j\omega)$ plot enters the unit disk for the first time.

Phase margin, PM $:= \pi + \angle G(j\omega_g)$

Example: Open loop pole on the imaginary axis.

$$G(s) = \frac{K}{s(s+1)(s+2)}$$





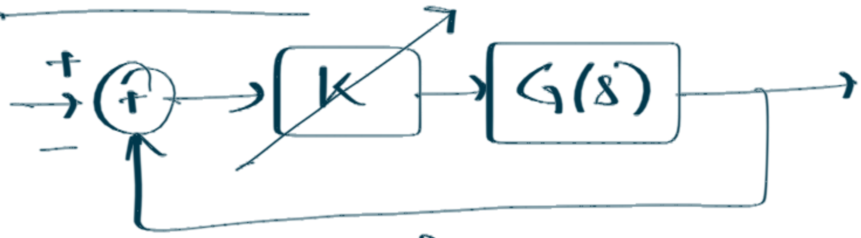
$$G(s) = \frac{s-1}{s^2(s+1)(s+2)}$$

Nyquist plot (HW).

- Nyquist plot is a freq. response plot.

Can be obtained from sinusoid i/o data of various freq.s.

Root locus:



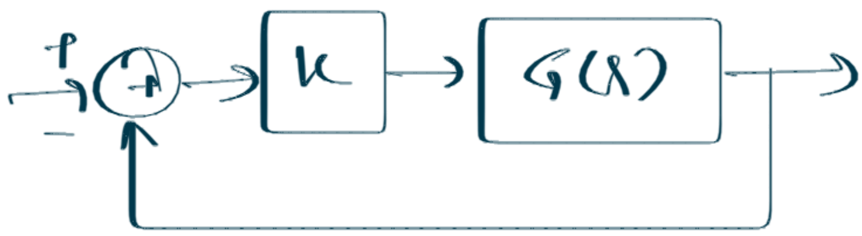
$$G(s) = \frac{p(s)}{q(s)} \quad \text{known}$$

$K = 0$ to $+\infty$.

$$CLTF = \frac{K G(s)}{1 + K G(s)}$$

Root locus shows the loci of the closed loop poles as k is varied from 0 to $+\infty$.

$$G(s) = \frac{1}{(s+1)(s+2)}$$



$$CLTF = \frac{K G(s)}{1 + K G(s)}$$

$$= \frac{\frac{K}{(s+1)(s+2)}}{1 + \frac{K}{(s+1)(s+2)}}$$

$$= \frac{K}{(s+1)(s+2) + K}$$

$$= \frac{K}{(s^2 + 3s + 2 + K)}$$

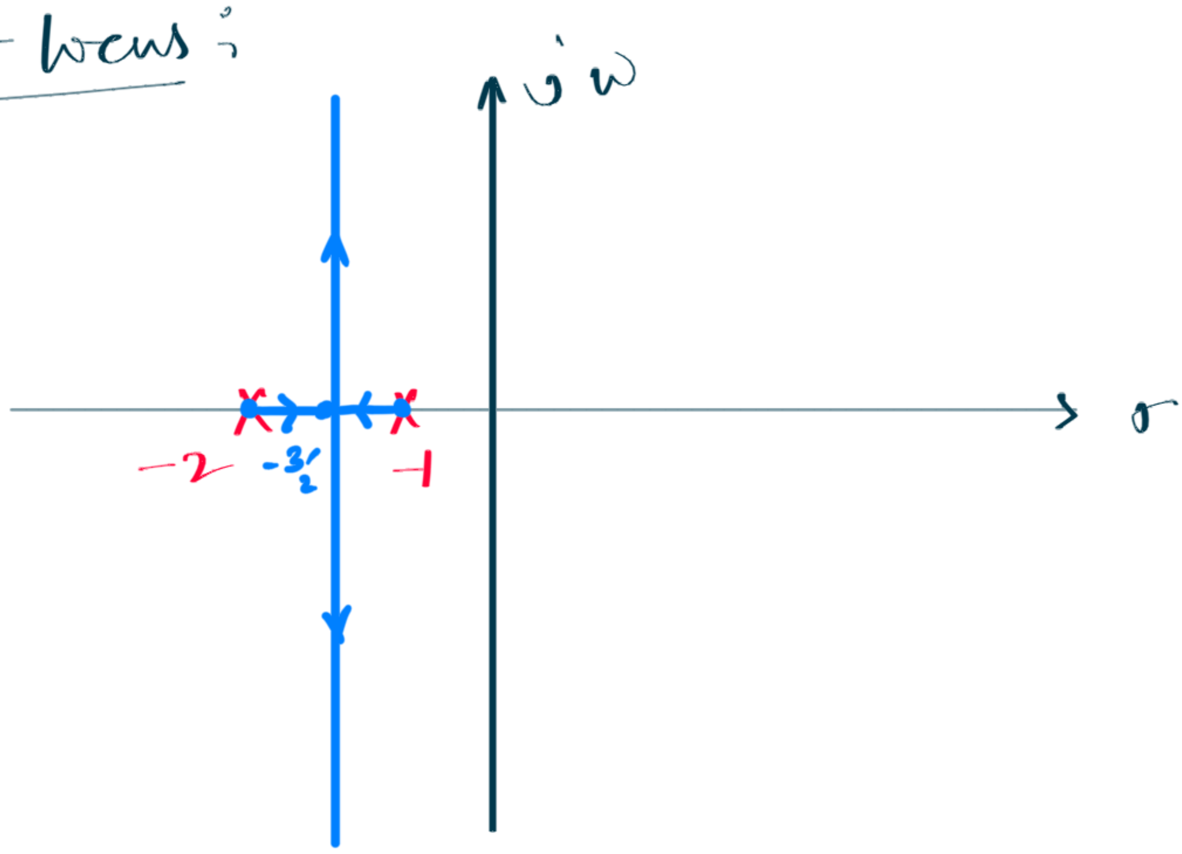
@ $K = 0$ $\quad \lambda = -1, -2$

$b^2 - 4ac$ = discriminant $= 9 - 4(2 + K)$

$= 9 - 8 - 4K$

$= \boxed{1 - 4K}$

Root locus :



$$G(s) = \frac{1}{(s+1)(s+2)(s+3)}$$