RULE #4: Pole Departure angle for pole w/ multiplicity q =

$$q\phi_{\ell,dep} = \sum_i \phi_i - \sum_{j\neq \ell} \phi_j - 180 - 360(\ell-1) \quad \ell = 1,2\ldots q$$

for zeros:

$$q\psi_{\ell,arr} = \sum_j \phi_j - \sum_{i\neq \ell} \psi_i + 180 + 360(\ell-1) \quad \ell = 1,2\ldots q$$

RULE #5: Locus crosses $j\omega$ axis where Routh shows roots from left → right half of plane.

transition.

aka a 0 in 1st column of Routh table.

$K=0$ ⇒ START @ poles.

if pole @ origin, also on Im axis

for other $K\neq 0$, solve $1+K \cdot L(s)=0$

assuming that $s=j\omega$.

RULE #6:

Locus has $\underbrace{\text{multiple roots}}_{\text{multiple branches meet}}$ @ $b\frac{da}{ds} - a\frac{db}{ds} = 0$

$$\frac{180+360(\ell-1)}{q}$$

$\ell = 1\ldots q$

b is numerator

a is denominator

branches $\boxed{\text{approach}}$ a point of q roots @ angles separated by

depart @ angles with the same separation

?? where to find q though?

LECTURE #12:

Assume multiple K gains: $H(s) = \dfrac{n(s)}{\underbrace{\alpha(s)+K_\beta \beta(s)}_{a(s)} + K_\gamma \underbrace{\gamma(s)}_{b(s)}} = \dfrac{n(s)/a(s)}{1+K_\gamma \underbrace{\boxed{\dfrac{\gamma(s)}{a(s)}}}_{L(s)}}$

compute K using a single pole (any). All poles move together as K ↑

$s^* \Rightarrow 1+K(L(s^*))=0$

$$K = -\frac{d(s^*)}{n(s^*)}$$

DOOR EXAMPLE

CONFUSING
AB
ANALYSIS