HALL
II

INTRA- HALL
TAKNEEK

Root Locus

Robotics PS

Team Invincible Boys

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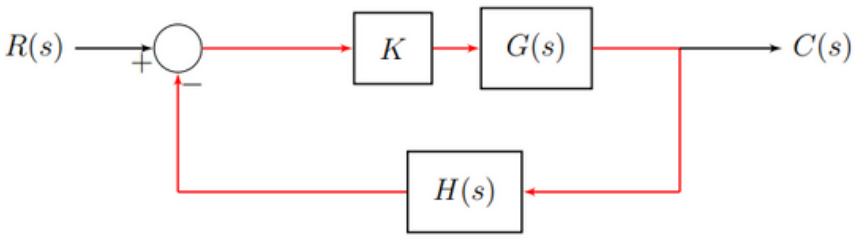
Terms to know

Root Locus | Asymptotes | **BreakAway/ BreakIn points** | jW Crossing | **Stability**

Root Locus

The Root locus is the locus of the roots of the characteristic equation by varying system gain K from zero to infinity.



Asymptotes

Asymptotes give the direction of these root locus branches.

BreakAway/ BreakIn points

If there exists a real axis root locus branch between two open loop poles or zeroes, then there will be a break-away point or break in point respectively between these two.

1.

jW crossing

A method of checking whether the plot will cross the jw axis or not which helps in determining stability.

Stability

The Values of K for which the system will lie on the left side of the graph as these are the points only where system is stable,

Formulae to know

P= no. of poles
Z= no. of zeroes

No. of branches of root locus = Max(P,Z)

No. of Asymptotes= |P-Z|

Real Axis intercept (Sigma) = ($\sum$ P - $\sum$ Z) / |P-Z|

Asymptote Angle= (2a+1)*pie/ P-Z

Break Away/In points = points s where dk/ds =0

For jw crossing put s=jw and solve for k.

Values on Solving

P= no. of poles Z= no. of zeroes

a) $$KG(s)H(s) = \frac{K}{(s+1)(s+2)}.$$

P= 2
Z=0
Branch of Root locus = 2
Real axis segment = (-2,-1)
No. of asymtotes= 2
Real Axis intercept = -1.5
Asymptote angle = pie/2, 3*pie/2
Breakaway point = -1.5
Breakaway Angle= pie/2
No jw crossing

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b) $$KG(s)H(s) = \frac{K(s+3)}{(s+1)(s+2)}.$$

P= 2
Z=1
Branch of Root locus = 2
Real axis segment = (-inf,-3) U (-2,-1)
No. of asymtotes= 1
Real Axis intercept = 0
Asymptote angle = pie
Breakaway point = -1.58
BreakIn point = -4.4142
Breakaway Angle= pie/2
No jw crossing

Values on Solving

P= no. of poles Z= no. of zeroes

(C) $KG(s)H(s) = \frac{K(s+3)(s+4)}{(s+1)(s+2)}$.

P= 2
Z=2
Branch of Root locus = 2
Real axis segment = (-2,-1) U (-3,-4)
No. of asymtotes= 0
Real Axis intercept = --
Asymptote angle = --
Breakaway point = -1.64
BreakIn point = -3.36
Breakaway Angle= pie/2
No jw crossing

(D) $KG(s)H(s) = \frac{K(s+2)(s+4)}{(s+1)(s+3)}$.

P= 2
Z=2
Branch of Root locus = 2
Real axis segment = (-4,-3) U (-2,-1)
No. of asymtotes= 0
Real Axis intercept = --
Asymptote angle = --
Breakaway point = --
BreakIn point = --
Breakaway Angle= ---
No jw crossing

Values on Solving

P= no. of poles Z= no. of zeroes

(E) $KG(s)H(s) = \dfrac{K}{(s^2+2s+5)}.$

P= 2
Z=0
Branch of Root locus = 2
Real axis segment = --
No. of asymtotes= 2
Real Axis intercept = -1
Asymptote angle = pie/2, 3*pie/2
Breakaway point = --
BreakIn point = --
Angle of Departure = pie/2 and -pie/2
No jw crossing

(F) $KG(s)H(s) = \dfrac{Ks}{(s^2+2s+5)}.$

P= 2
Z=1
Branch of Root locus = 2
Real axis segment = (-inf,0)
No. of asymtotes= 2
Real Axis intercept = -2
Asymptote angle = pie
Breakaway point = --
BreakIn point = root 5
Breakaway Angle=pie/2
Angle of departure= 116.56 and -116.56
No jw crossing

Values on Solving

P= no. of poles Z= no. of zeroes

$$\text{(G)}\quad KG(s)H(s) = \frac{K}{(s+1)(s+2)(s+3)}.$$

P= 3
Z=0
Branch of Root locus = 3
Real axis segment = (-inf,-3) U (-2,-1)
No. of asymtotes= 3
Real Axis intercept = -2
Asymptote angle = pie/3, 5*pie/3,pie
Breakaway point = -1.423
BreakIn point = --
BreakAway angle= pie/2
jw crossing for w = root 11 and unstable system for k>60.
No jw crossing

Corresponding Plots are attached with the python code with this file.

Thank You