



SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)
COIMBATORE-35



UNIT IV
ROOT LOCUS



Rules for Construction of Root Locus

- **Rule 1 – Locate the open loop poles and zeros in the ‘s’ plane**
- **Rule 2 – Find the number of root locus branches.**
 - The root locus branches start at the open loop poles and end at open loop zeros. So, the number of root locus branches N is equal to the number of finite open loop poles P or the number of finite open loop zeros Z , whichever is greater
 - Mathematically, we can write the number of root locus branches N as

$$N = P \text{ if } P \geq Z$$

$$N = Z \text{ if } P < Z$$



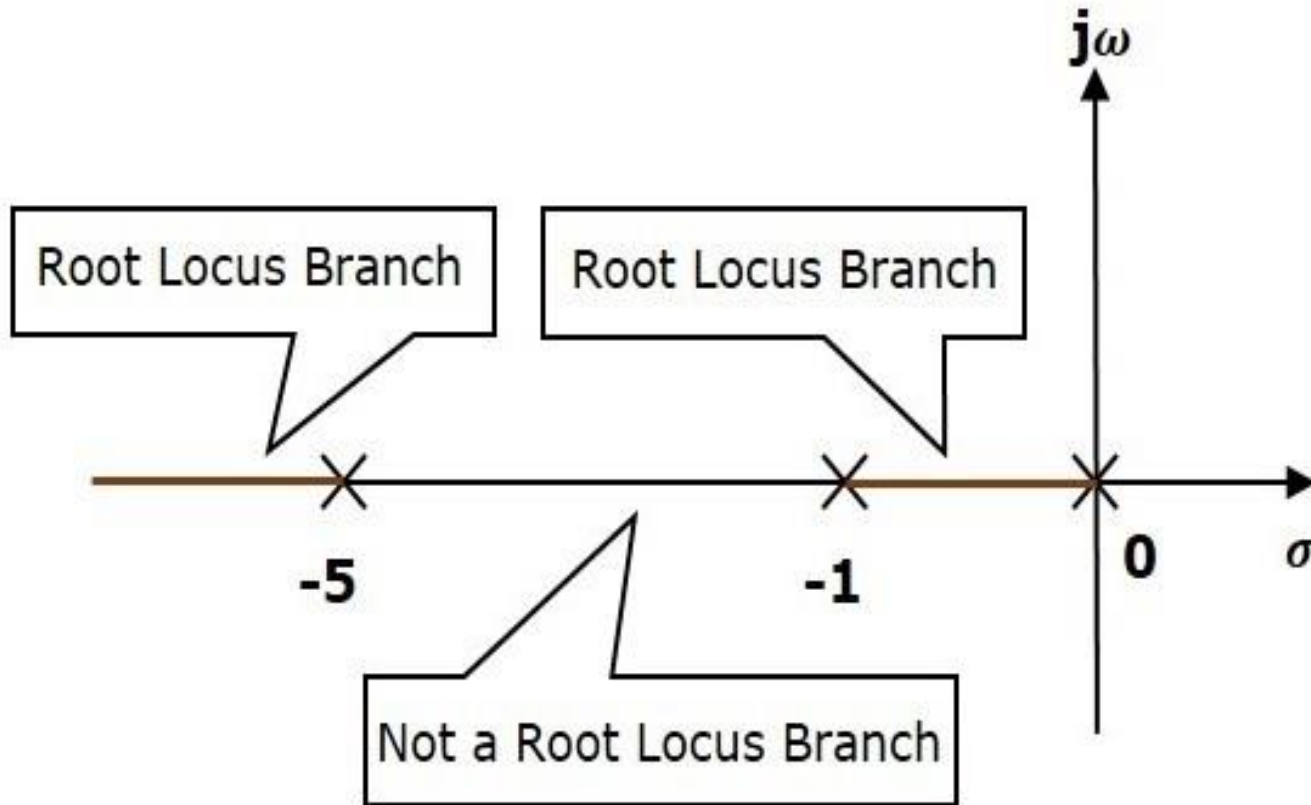
Rules for Construction of Root Locus



- **Rule 3 – Identify and draw the real axis root locus branches.**
 - If the angle of the open loop transfer function at a point is an odd multiple of 180° , then that point is on the root locus.
 - If odd number of the open loop poles and zeros exist to the left side of a point on the real axis, then that point is on the root locus branch.
 - Therefore, the branch of points which satisfies this condition is the real axis of the root locus branch.



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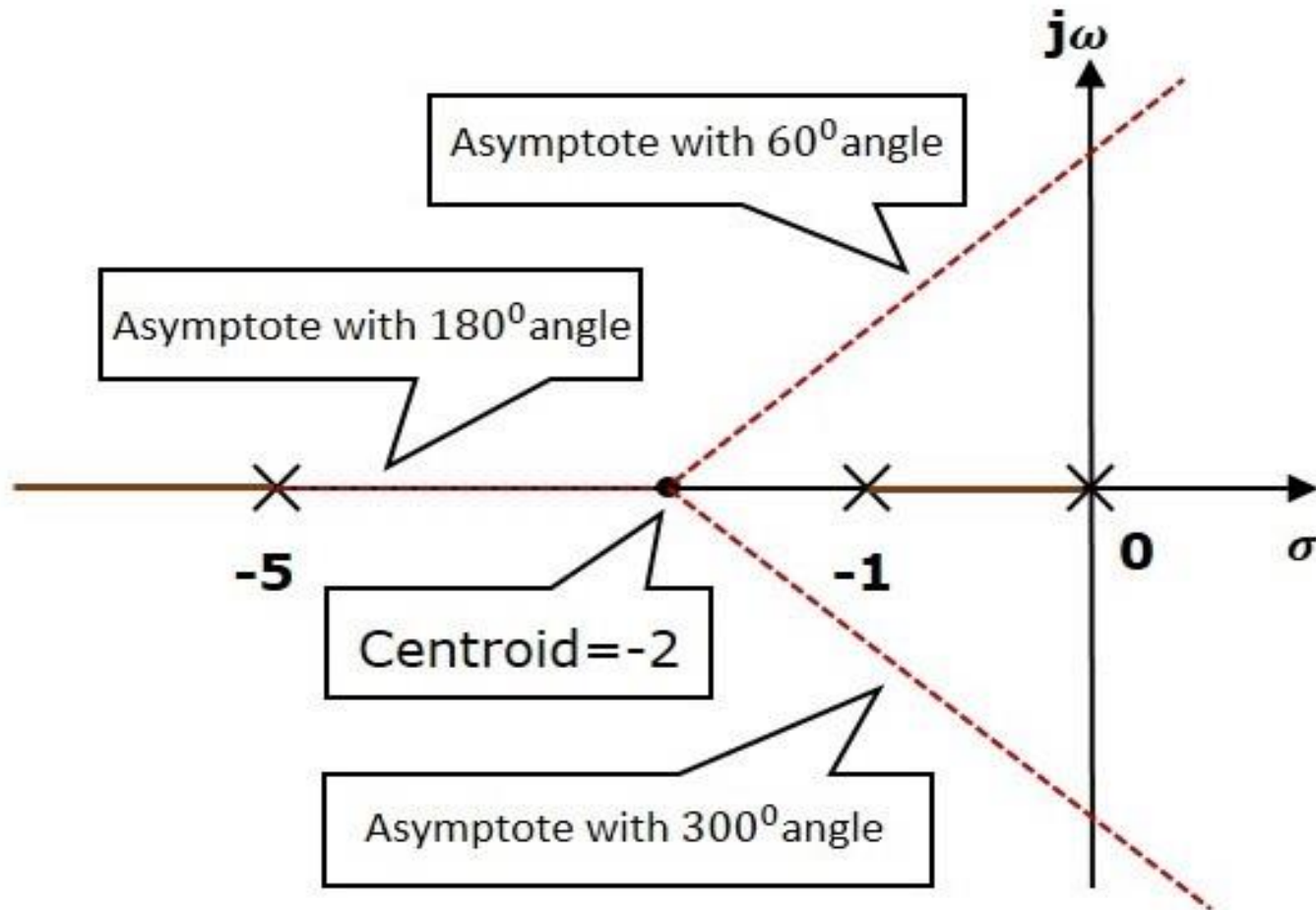
- **Rule 4 – Find the centroid and the angle of asymptotes**
 - If $P=Z$, then all the root locus branches start at finite open loop poles and end at finite open loop zeros.
 - If $P>Z$, then Z number of root locus branches start at finite open loop poles and end at finite open loop zeros and $P-Z$ number of root locus branches start at finite open loop poles and end at infinite open loop zeros.
 - If $P<Z$, then P number of root locus branches start at finite open loop poles and end at finite open loop zeros and $Z-P$ number of root locus branches start at infinite open loop poles and end at finite open loop zeros.

Centroid = Sum of poles – Sum of zeros / (n-m)

The angle of asymptotes = $180(2q\pm 1) / (n-m)$



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- **Rule 5 – Find Break-away and Break-in points.**
 - If there exists a real axis root locus branch between two open loop poles, then there will be a break-away point in between these two open loop poles.
 - If there exists a real axis root locus branch between two open loop zeros, then there will be a break-in point in between these two open loop zeros
- Write K in terms of ss from the characteristic equation $1+G(s)H(s)=0$.
- Differentiate K with respect to s and make it equal to zero. Substitute these values of ss in the above equation.
- The values of ss for which the K value is positive are the **break points**.



Rules for Construction of Root Locus



- **Rule 6 – Find the angle of departure and the angle of arrival.**
 - The Angle of departure and the angle of arrival can be calculated at complex conjugate open loop poles and complex conjugate open loop zeros respectively
- **Rule 7 – Intersection point on imaginary axis**
 - Substitute $s=j\omega$ in the characteristic equation and equate real part and imaginary part to zero separately



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