



SNS COLLEGE OF TECHNOLOGY

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Department of Biomedical Engineering

Course Name: Control Systems

III Year : V Semester

Unit II -Time Response Analysis

Topic : 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

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

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



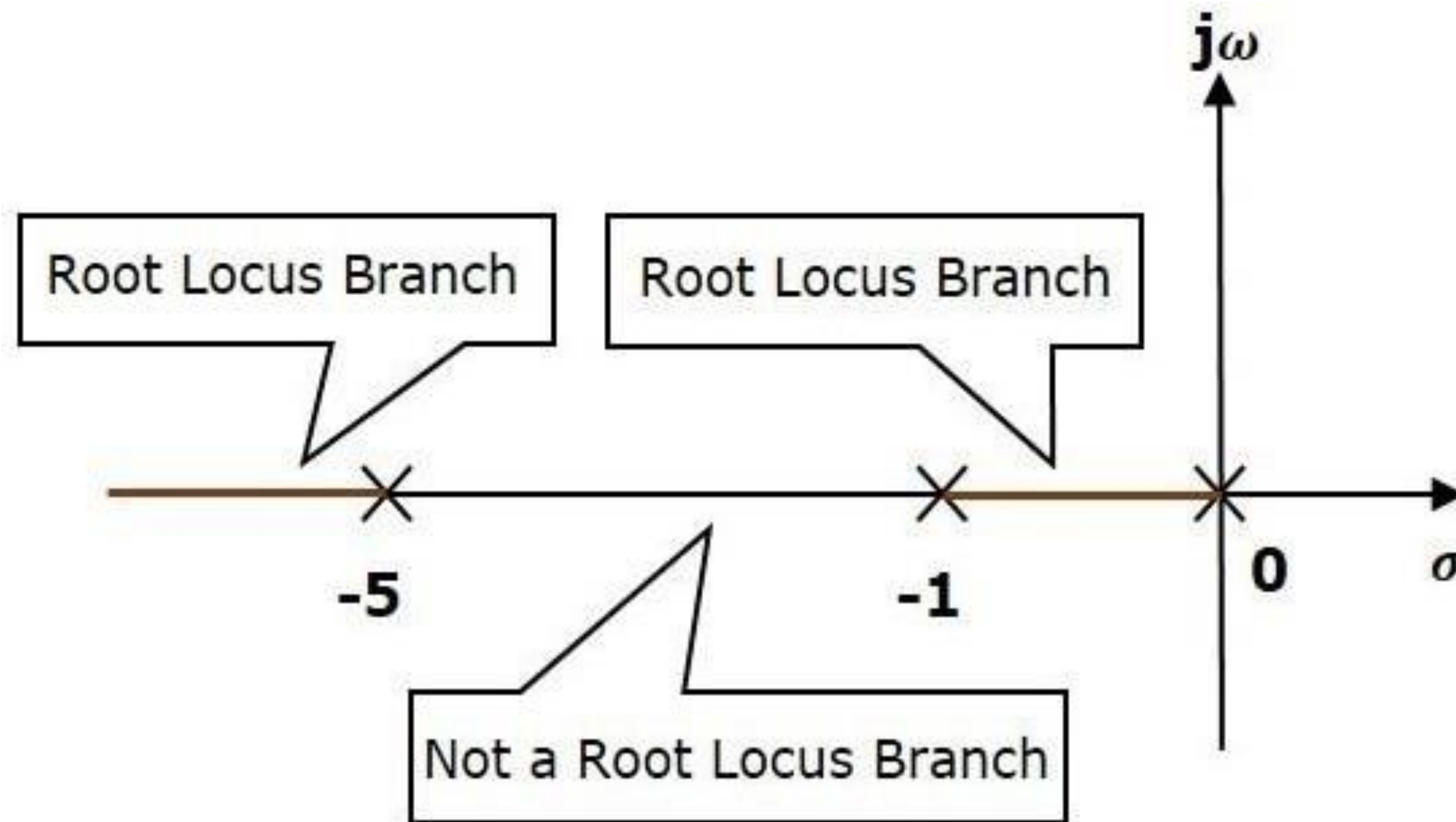
Rules for Construction of Root Locus

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.



Rules for Construction of Root Locus





Rules for Construction of Root Locus

Rule 4 – Find the centroid and the angle of asymptotes

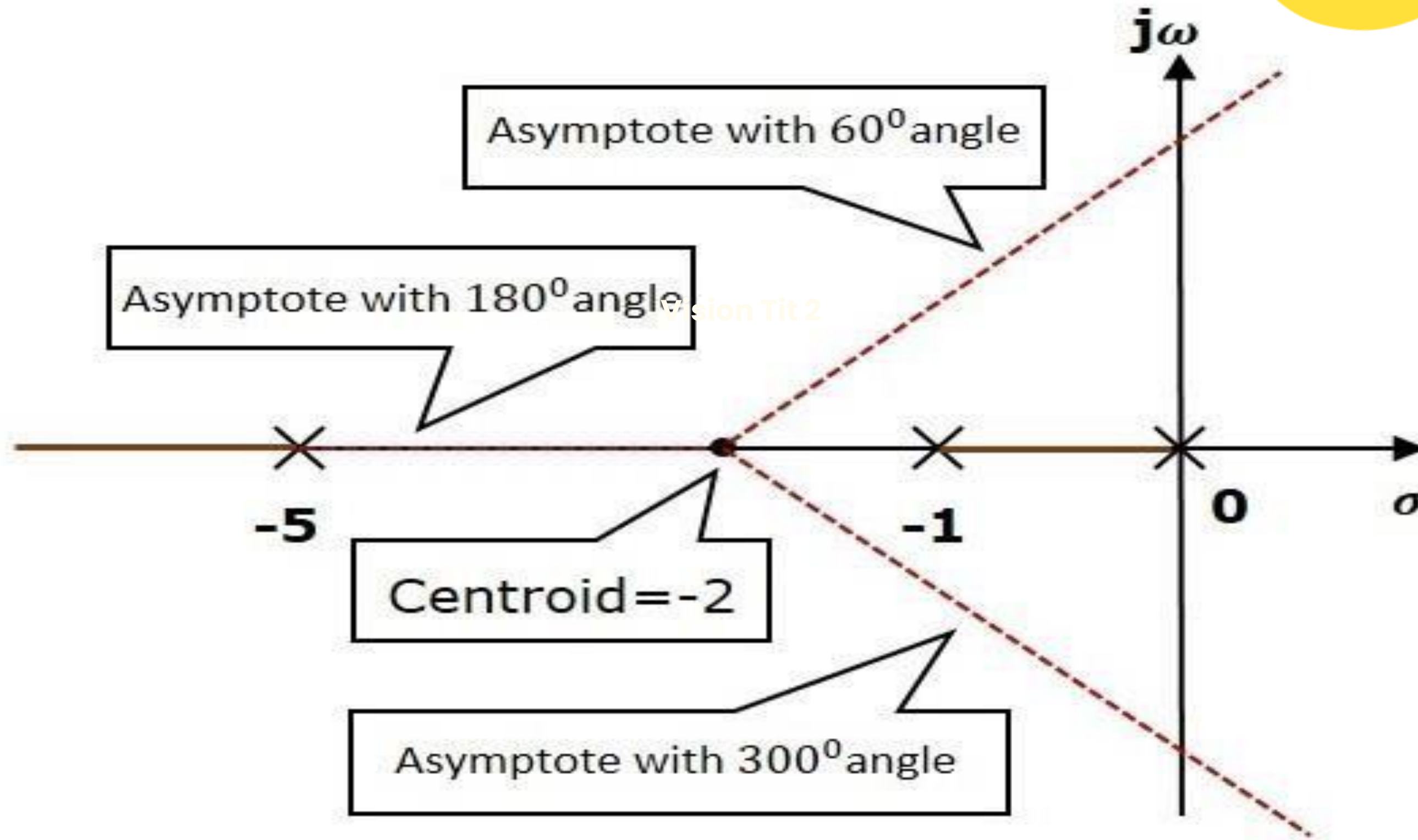
- If $P=Z$, then all the root locus branches start at finite open loop poles and end at finite open loop zeros.
- If $P>Z$, then Z number of root locus branches start at finite open loop poles and end at finite open loop zeros and $P-Z$ number of root locus branches start at finite open loop poles and 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.

$$\text{Centroid} = \frac{\text{Sum of poles} - \text{Sum of zeros}}{(n-m)}$$

$$\text{The angle of asymptotes} = \frac{180(2q \pm 1)}{(n-m)}$$



Rules for Construction of Root Locus





Rules for Construction of Root Locus

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 s 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 s in the above equation.
- The values of s 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



Rules for Construction of Root Locus

