# 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 Technique

# 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

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

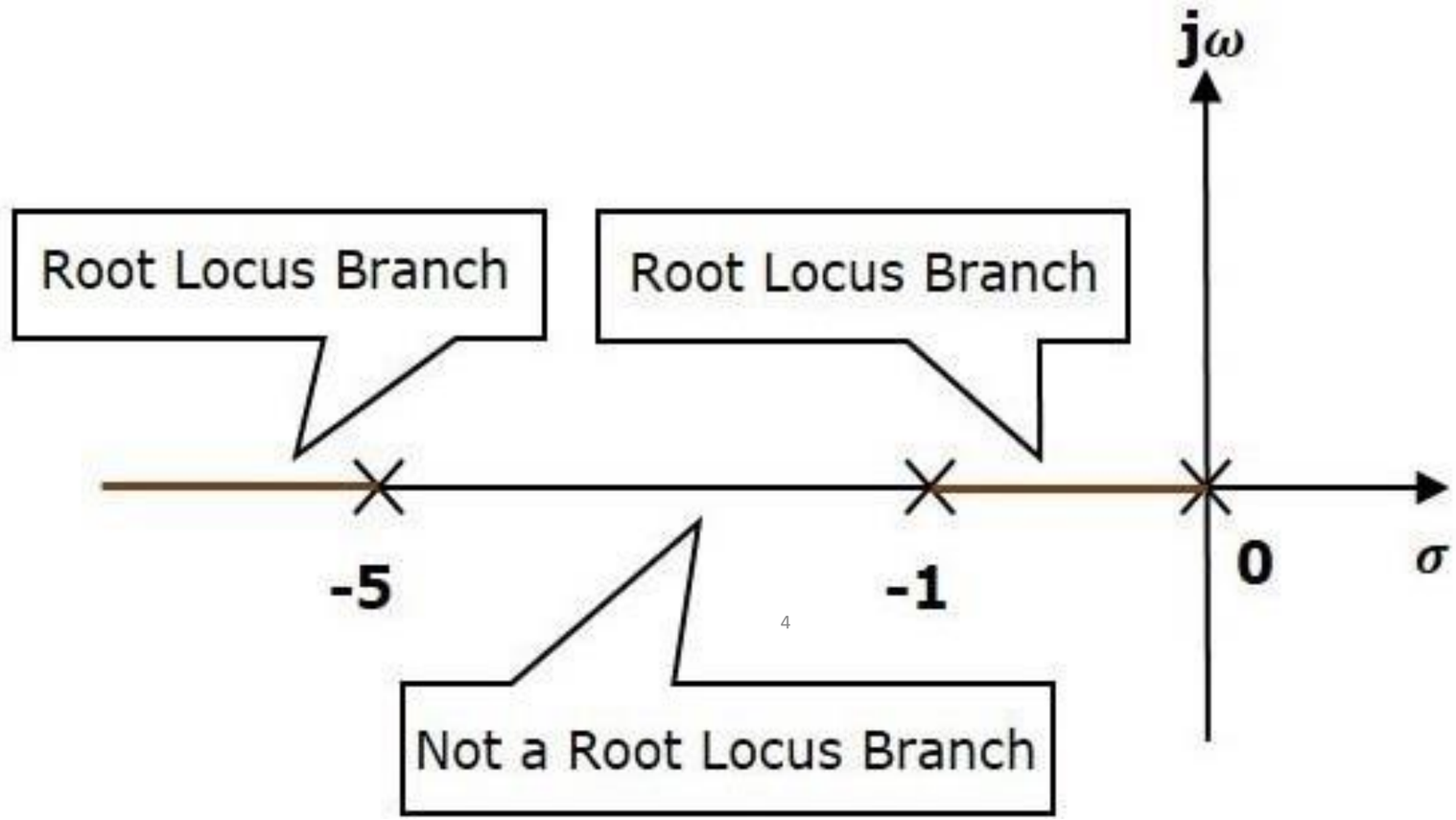
$$N = Z \text{ if } P < Z$$

# 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

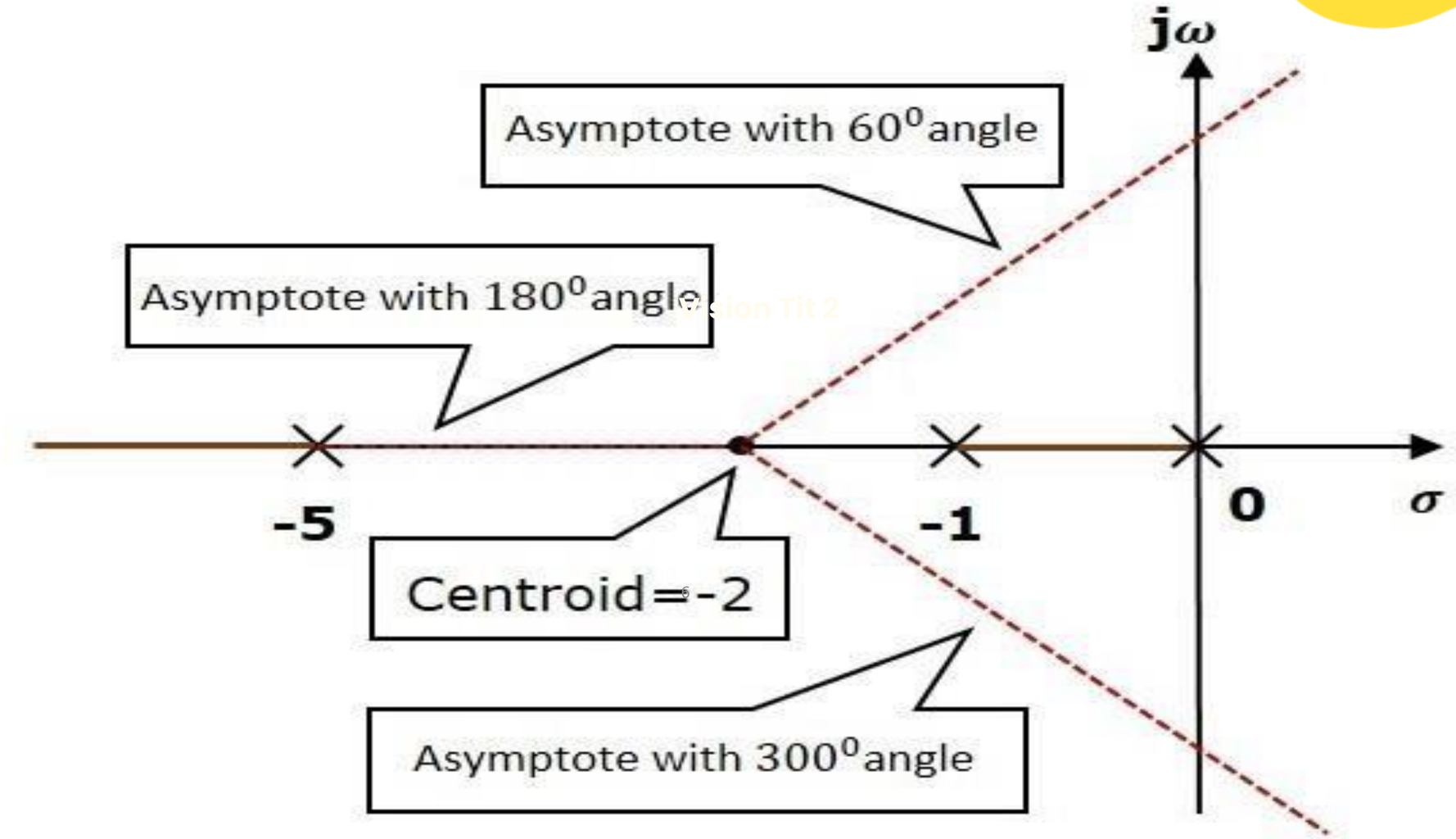
## Rule 4 – Find the centroid and the angle of asymptotes

- 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.

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

**The angle of asymptotes = 180(2q±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

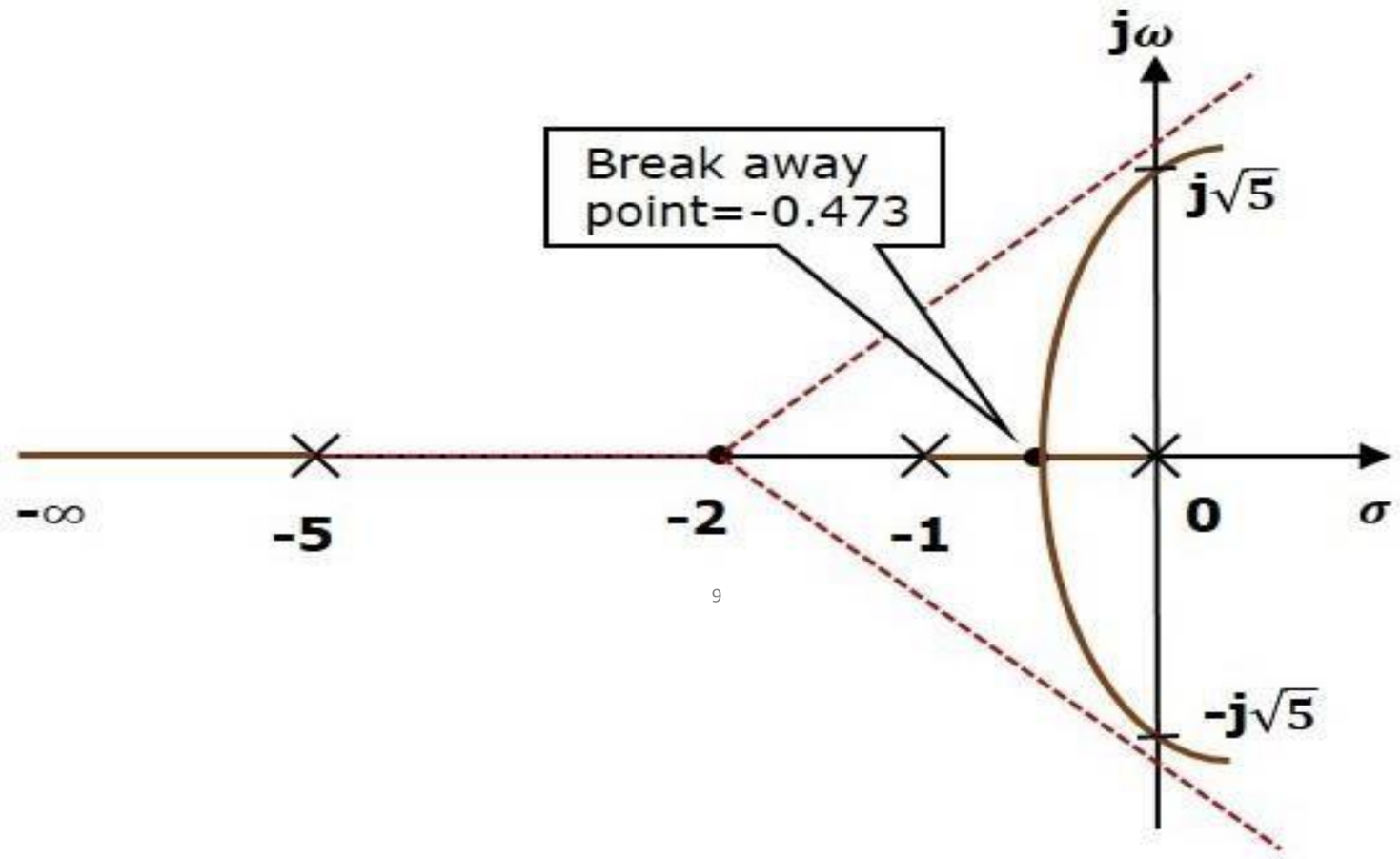
## Rule 6 – Find the angle of departure and the angle of arrival.

- 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=jω in the characteristic equation and equate real part and imaginary part to zero separately

# Rules for Construction of Root Locus



# Thank You