Course Name	Course Number	Semester
Machine Design I	0904435	Spring2022/2023

Deflections of Beams by the Virtual-Work Method – Procedure for Analysis

1. **Real System:** Draw a beam diagram showing all real loads.
2. **Virtual System:** Draw a diagram of the beam with all real loads removed. If a beam deflection is to be determined, apply a unit load at the location desired for the deflection. If a beam slope is to be determined, apply a unit moment at the desired location.
3. **Subdivide the Beam:** Examine both the real and virtual load systems. Also, consider any variations of the flexural rigidity EI that may exist in the beam. Divide the beam into segments so that the equations for the real and virtual loadings, as well as the flexural rigidity EI, are continuous in each segment.
4. **Derive Moment Equations**: For each segment of the beam, formulate an equation for the bending moment **m** produced by the virtual external load. Formulate a second equation expressing the variation in the bending moment M produced in the beam by the real external loads. Note that the same x coordinate must be used in both equations. The origin for the x coordinate may be located anywhere on the beam and should be chosen so that the number of terms in the equation is minimized. Use the standard Convention for bending-moment signs for both the virtual and real internal-moment equations.
5. **Virtual-Work Equation:** Determine the desired beam deflection by applying Equation or compute the desired beam slope. If the beam has been divided into segments, then you can evaluate the integral on by algebraically adding the integrals for all segments of the beam. It is, of course, important to retain the algebraic sign of each integral calculated within a segment.

If the algebraic sum of all of the integrals for the beam is positive, then Δ or $\boldsymbol{\theta}$ is in the same direction as the virtual unit load or virtual unit moment.

If a negative value is obtained, then the deflection or slope acts opposite to the direction of the virtual unit load or virtual unit moment.