# Shear Force and Bending Moment Diagrams

## Shear Force and Bending Moment Diagrams

### 1. Analyze the Problem

- **Identify the beam type:** Determine whether it's simply supported, cantilevered, or continuous.
- **List all loads and supports:** Include point loads, distributed loads, moments, and reactions.

### 2. Calculate Support Reactions

1. **Free-Body Diagram (FBD):** Draw the beam with all external forces, moments, and reactions.
2. **Equilibrium Equations:** Use these to solve for the reactions at the supports:

- $\sum F_y = 0$ (Vertical force equilibrium)
- $\sum M = 0$ (Moment equilibrium about any point)

### 3. Break the Beam into Segments

Divide the beam into sections based on the locations of loads, supports, and discontinuities. Label each segment.

### 4. Write Equations for Shear Force and Bending Moment

- **Shear Force** $V(x)$: The algebraic sum of vertical forces to the left or right of the section.
- **Bending Moment** $M(x)$: The algebraic sum of moments about the section.

### 5. Plot the Shear Force Diagram (SFD)

1. **Start at zero at the ends of the beam** (for simply supported beams or free ends).
2. **Add or subtract forces at load points:**
   - A point load changes the shear force instantaneously by its magnitude.
   - A distributed load causes a slope in the SFD.
3. **Mark zero-crossings:** Identify points where the shear force changes sign, indicating a potential maximum or minimum bending moment.

### 6. Plot the Bending Moment Diagram (BMD)

1. **Start with the calculated moments at the supports or free ends.**
2. **Integrate the shear force:** The area under the SFD gives the bending moment.
3. **Apply boundary conditions:**
   - Fixed ends: Zero slope (moment is maximum/minimum).
   - Simply supported ends: Zero moment.
   - Free ends: Zero shear force and moment.

### 7. Verify the Results

- **Boundary Conditions:** Ensure the diagrams match the physical behavior of the beam.

## Summary

| **Load Type** | **Shear Diagram Shape** | **Moment Diagram Shape** |
|---|---|---|
| Point Load | Rectangular (constant) | Triangular |
| Uniformly Distributed Load (UDL) | Triangular | Parabolas (second degree) |